THE UNIVERSITY OF MANITOBA

THE EPIDEMIOLOGY OF MALOCCLUSION IN TWELVE YEAR OLD WINNIPEG SCHOOL CHILDREN

by

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A THESIS SUBMITTED TO THE FACULTY OF GRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

DEPARTMENT OF DENTAL SCIENCE

Winnipeg, Manitoba

February, 1972

ABSTRACT

In the past 150 years numerous investigators have attempted to classify the various forms of malocclusion found in the human population. The most widely accepted classification was the one introduced by Angle in 1899 in which the maxillary first permanent molars were considered the "keys" to occlusion. The primary purpose of this and other classifications was to enable the clinical orthodontist to group the various types of malocclusion into certain broad categories so that diagnosis and communication with peers would be facilitated.

With the growing trend towards third-party prepaid orthodontic programs and the possibility of government supported insurance plans, there has been an increasing demand for a more quantitative and less subjective method to evaluate malocclusion and establish treatment priorities. This has lead to the introduction of several indices of malocclusion.

The primary purpose of these indices was to quantitatively express the degree of malocclusion so that investigators could estimate its prevalence and severity and determine treatment needs of a population. One of the major drawbacks to these indices was that they did not include a quantitative assessment of facial esthetics and for the most part considered only static dental relationships.

The present investigation was undertaken to characterize the status of malocclusion in a sample of Winnipeg school children; to determine the treatment needs and demands of this sample; and to examine several methods of establishing treatment priority.

A random survey of 444 twelve year old Winnipeg school children was conducted. Each child included in the study had a full permanent dentition with their cuspids and second molars erupted. The children were given a clinical examination in which twenty-six variables were recorded. In addition, a lateral black and white photograph was taken of 290 children for analysis.

The entire sample was examined as a group and then subgrouped on the basis of their sex, occlusion and socioeconomic level. For purposes of the present study children in the private schools were classified as being in the high socioeconomic level while children in the public schools and those attending the dental welfare clinics were classified in the medium and low socioeconomic groups, respectively.

The occlusion of each child was assessed according to the Angle method of classification and according to the Handicapping Labio-lingual Deviation Index and the Treatment Priority Index. In addition, a photographic index was developed to aid in the evaluation of handicapping malocclusion.

On the basis of the results of this study the following conclusions were drawn:

1. Approximately 85% of the children examined exhibited some form of malocclusion.
2. No child was found to have a perfectly ideal occlusion as some slight dental deviation was found in every child.
3. The indices of malocclusion suggested that approximately 23% of the total sample of children had a severe malocclusion.

4. The results of the two indices were not strictly comparable because each of them seemed to measure different aspects of malocclusion.

5. No relationship was found between socioeconomic level and the incidence or severity of malocclusion.

6. A definite relationship was found between socioeconomic level and orthodontic treatment. The higher the socioeconomic level, the more likely the child was to have either received treatment or at least have had treatment suggested.

7. In all but one case the children receiving orthodontic treatment were being treated by certified orthodontists and not by general dentists.

8. A photographic index was developed which, when used in conjunction with an index of malocclusion, may aid in the assessment of orthodontic treatment priority.

9. The predictibility of the photographic index should be improved through further investigation in this field.

10. There is an acute orthodontic treatment need in the population studied.

Until you can count it, weigh it, or express it in a quantitative fashion you scarcely have begun to think about a problem in a scientific way.

- Lord Kelvin -

ACKNOWLEDGEMENTS

This study could not have been carried to its completion without the co-operation of many persons; and although the names of most of them do not appear here, I gratefully acknowledge my indebtedness to all those who have contributed either directly or indirectly to this investigation.

I particularly wish to acknowledge the supervision and guidance provided by Professor J. F. Cleall, Head of the Department of Orthodontics, University of Manitoba.

I wish to thank Dr. A. Yip, Dr. L. Melosky and Dr. E. Cohen for their assistance during the course of this study.

A special thanks to Dr. F. Chebib for his aid in developing the computer programs used in this investigation and for making possible the statistical evaluation of the raw data.

Acknowledgement is given to Miss I. Mikola for typing this manuscript.

The author would like to thank the Winnipeg School Board and the principals of the public schools included in this study, for permitting those schools to participate in the study, and also, for providing the facilities necessary for conducting the examinations. In this connection I would especially like to thank Mr. W. N. Donald, Superintendent of Winnipeg Elementary Schools.

In addition, I wish to express my appreciation to Mr. C. Kiddell, Mr. J. Vilenski and Dr. H. Perry, principals of the private schools involved in this study for their kind permission in allowing their schools to participate in this investigation.

I would also like to thank Dr. L. Konyk, Director of the Winnipeg Public School Dental Clinics and his staff for the unselfish assistance they provided in making the necessary arrangements for a survey of the dental clinics.

A special thanks to Dr. and Mrs. G. Mass for their assistance and encouragement in the preparation of this manuscript.

Finally, I wish to thank my wife Marilyn and my sons, Hartley and Bobby, for their aid and encouragement during the course of this study.

This research was supported by Medical Research Council Grant MA-3541 and National Health and Welfare Grant 606-7-222.

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INTRODUCTION

In recent years there has been an increasing trend towards the socialization of medical services. In many Canadian provinces an individual's total medical and hospital needs are now underwritten by government controlled insurance plans. An investigation into the evolution of these plans reveals that in almost every case a similar type of insurance was available from private insurance companies (Reynolds, 1971). However, when the governments assumed control they introduced non-competitive, monopolistic plans. There are many political implications and ramifications involved in the socialization of any sector of the economy. The basis for the socialization of medical services stems from the public's demand that every citizen in a democracy has the right to enjoy good health and receive proper medical treatment.

In contrast to the medical plans, prepaid dental plans are still in their embryological stage of development. If the past experience in the medical field is used as a guide, it is evident that the future will include an increasing number of dental plans underwritten by private insurance companies. When these plans prove operable, it is probable that the government will assume control in order to provide the maximum benefits to the majority of the population.

With the prospect of prepaid dental insurance and publicly funded

dental programs, there arises the need for adequate quantitative information concerning the prevalence, distribution and severity of dentofacial anomalies as well as the treatment demands and requirements of the population. This has resulted in the introduction of numerous indices of malocclusion which, for the most part, have been based entirely on the occlusion of the teeth with no consideration given to facial harmony.

Although no single index has been universally adopted, both the Index of Handicapping Labio-lingual Deviations (Draker, 1958) and the Treatment Priority Index (Grainger, 1966) have been used in several epidemiological investigations. The results of these studies indicated that there appears to be geographic differences in the prevalence and severity of malocclusion.

It was therefore decided that an epidemiological investigation of malocclusion in Winnipeg school children should be conducted with the following aims:

1. To determine the incidence and severity of malocclusion in a group of twelve year old Winnipeg school children using the Treatment Priority Index and the Handicapping Labio-lingual Deviation Index.
2. To determine the treatment needs and requirements of the children examined.
3. To determine the number of children receiving orthodontic treatment by either their family dentist or by an orthodontist.
4. To determine the number of children referred to an orthodontist for treatment.
5. To determine if any relationship exists between socioeconomic level and the prevalence or severity of malocclusion.

6. To develop a photographic index for use in conjunction with an index of malocclusion.

7. To compare the results of the two indices used.

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Historical Review

Awareness of dental anomalies and occlusal irregularities in human skulls can be dated back to Neanderthal man approximately 50,000 years ago. The fact that malocclusion existed in primitive man has always been of great interest to those concerned with the study of the man's historical and evolutionary origins.

Archeological finds have indicated that malocclusion occured in prehistoric times with the earliest documented reports made by Hippocrates in the sixth book of Epidemics. Hippocrates described the relationship between irregularities of the teeth, malformations of the skull and palate form. Various forms of malocclusion were also recorded by Aristotle, Diocles and Celsus, the first to write on treatment and preventive orthodontics. The historical significance of these and other ancient writings cannot be denied, nevertheless, they give little information concerning the classification, prevalence or severity of malocclusion which existed.

A survey of past literature by Weinberger (1926) revealed that the first classification of malocclusion, introduced by Fox (1803), was based on the differences in relationships of the anterior teeth. Delabarre (1819) modified Fox's classification and introduced terminology to describe the relationship of the incisor teeth. The terms which he

proposed were overbite, underbite, edge to edge and crossbite. Marjolin (1823) introduced the terms of prominence, recession and inversion to describe malpositions of the arches. Other men who proposed classifications of malocclusion during this era were: Bell (1829), Blandin (1836) and Schange (1841). In 1842 Carabelli published his classification which was based on the "bite". He described the following forms of incisor relation; normal, edge to edge, crossbite and introduced the term openbite. These early classifications gave no indication of the incidence or severity of malocclusion. Their prime importance was that they established a basic terminology which could be used by future investigators in the description of malocclusion.

Ottofy (1888) was one of the earliest dental investigators to study the prevalence of malocclusion. He examined 623 boys and girls between the ages of five and fifteen grouping problems of malocclusion according to the number of "irregularities" in each case. The findings of this study revealed that 25% of the twelve year old children had some degree of malocclusion.

In 1890 Talbot devised a chart for the use in the examination and classification of malocclusion. Studying 1,000 students over twelve years of age, he categorized the problems of malocclusion under the following headings; large jaws, protracted lower jaw, thumb sucking and small teeth. Talbot claimed to consider only "local factors" influencing malocclusion and reported a 45% incidence of malocclusion in children over twelve years of age.

Although it is possible that the differences in prevalence figures obtained by Ottofy and Talbot were caused by sample differences in age, sex and racial background, it is more likely that these variations stemed from lack of a uniformly accepted classification of malocclusion.

Classification of Malocclusion

In 1899 Angle introduced his classification of malocclusion. This classification was based on the mesiodistal relation of the teeth, dental arches and jaws, which he felt depended primarily on the position assumed by the first permanent molars; the "Keys" to occlusion.

Angle (1899) listed three main classes of malocclusion:

Class I Malocclusion in which there is a normal mesiodistal relationship of the mandible to the maxilla. There is, however, malocclusion of the individual teeth.

Class II Malocclusion in which there is a distal relationship of the mandible to the maxilla.

Class II Division 1 A Class II occlusion in which the maxillary incisor teeth are labially inclined.

Class II Division 2 A Class II occlusion in which the maxillary incisor teeth are near normal antero-posteriorly or slightly lingually inclined.

Class III Malocclusion in which there is a mesial relationship of the mandible to the maxilla.

Unilateral deviations of Class II and Class III malocclusions were designated as subdivisions of the affected side.

Because of its simplicity, the Angle classification was quickly adopted by clinical orthodontists and used to group various types of

malocclusion into the three broad classes described. This facilitated the description of sagittal jaw relationships and thereby improved communication between orthodontists. The disadvantage of this classification was that it divided all malocclusions into three distinct, discrete entities, namely Class I, II, and III and their subdivisions, rather than regarding malocclusion as a continuous variable on a graduated scale. Because of this, little information was provided concerning the severity of malocclusion or the need for treatment.

In order to characterize malocclusion in a more detailed manner, Lischer (1912) introduced an alternate terminology for the designation of Angles' Class I, II and III malocclusion. He referred to Class I as neutroclusion, Class II as distoclusion and Class III as mesioclusion. He designated arch position by the suffix occlusion, as buccoclusion, linguoclusion, supraclusion and infraclusion. Malpositions of the teeth were indicated by the suffix version, as labioversion and bucoversion. Classification of a malocclusion in the manner suggested by Lischer required a detailed description of each tooth. This proved too cumbersome for use in epidermiological surveys and has never been used as such.

Dewey (1915) made some useful additions to Angle's classification by suggesting that Class I cases by subdivided into types I, II, III, IV and V and a Class II into types I, II and III. These modifications demonstrated that various types and degrees of malocclusion could exist within each of Angle's classes. Although limited to ten classes this

was the first attempt to describe malocclusion as a continuous variable. Unfortunately, no epidemiological studies were carried out based on Dewey's modifications.

Simon (1926) attempted to broaden the concept of occlusion by relating the teeth to the rest of the face and cranium by establishing the "orbital law". He stated that the perpendicular to the Frankfort plane passed through the distal third of the maxillary canine in normal occlusion. In this way he was able to relate the spatial positions of the dentition to the face. Historically this classification was important because it was the first to consider the interdependence of the teeth, jaws and craniofacial structures; however, from a practical standpoint Simon's classification was never widely used by orthodontists in either clinical or epidemiological investigations.

According to Moller (1969), the continued, widespread use of Angle's classification demonstrates that it has withstood the "test of time" as a workable classification of malocclusion. Emrich, Brodie and Blayney (1965) stated that there was general agreement among orthodontists as to what constituted a Class I, II or III malocclusion. This may account for the persistent use of this classification. In spite of the persistent and continued use of Angle's classification in clinical and epidemiological investigations, large differences have been reported in the prevalence of the various classes of malocclusion. The results of twenty-nine studies which employed Angle's method of classification is presented in Table I. The reported incidence of malocclusion ranged from

TABLE I

INCIDENCE OF THE VARIOUS ANGLE CLASSES OF MALOCCLUSION REPORTED IN TWENTY-NINE INVESTIGATIONS

Investigator	Country	Year	Sample Size	Age (Years)	Per Cent Malocclusion					
						Class II				
					Class I	Div 1	Div 2	Total	Class III	Total Malocclusions
Korkhaus	Germany	1927	568	14	41.7	--	--	13.2	0.5	55.4
Munblatt	U. S. A.	1943	1214	6-14	38.2	9.2	13.1	22.3	1.7	62.2
Sclare	Britain	1945	334	12	30.1	--	--	28.0	1.0	59.1
Hubber and Reynolds	U. S. A.	1946	500	16	63.6	4.8	10.8	15.6	12.2	91.4
Brandhorst	U. S. A.	1946	8748	12-13	39.9	--	--	13.7	2.1	55.7
Massler and Frankel	U. S. A.	1951	2758	14-18	50.1	16.7	2.7	19.4	9.4	78.9
Krogman	U. S. A.	1951	586	6-12	28.0	21.0	3.4	24.4	1.7	54.1
Barrow and White	U. S. A.	1952	51	16	39.0	--	--	36.0	12.0	87.1
Jackson	Britain	1952	1070	8-17	37.6	--	--	9.6	1.6	48.8
Friedlander	U. S. A.	1953	398	Adult	55.8	12.0	13.0	25.0	4.3	85.1
Andirk	Slovakia	1954	5022	6-15	40.6	8.8	1.6	10.4	1.5	52.5
Newman	U. S. A.	1956	3355	6-14	38.2	--	--	13.2	0.5	51.9
Gardiner	Britain	1956	1000	6-15	66.7	3.0	0.8	8.1	0.4	74.2
Adler	Hungary	1956	4230	16-18	25.0	6.8	8.7	15.5	1.7	42.2
Goose et al	Britain	1957	2956	7-15	24.8	11.7	4.4	16.1	2.9	43.8
Popovich	Canada	1958	199	12	54.4	--	--	31.6	2.0	88.0
Altemus	U. S. A.	1959	3289	12-16	66.4	10.5	1.6	12.1	5.0	83.5
Hill et al	U. S. A.	1959	4131	12-14	34.0	--	--	14.0	1.0	49.0
Rosenzweig	Israel	1961	214	13-14	23.8	22.6	6.2	28.8	0.5	53.1
Brehm and Jackson	U. S. A.	1961	6328	6-18	60.1	--	--	22.8	0.5	83.4
Ast et al	U. S. A.*	1962	160	13-14	42.7	--	--	20.9	1.2	64.8
Ast et al	U. S. A.**	1962	142	13-14	51.4	--	--	32.4	3.5	87.3
Ast et al	U. S. A.	1965	1446	15-18	69.8	8.8	5.0	23.8	1.6	95.2
Emrich et al	U. S. A.	1965	13475	12-14	30.0	--	--	15.0	1.0	46.0
McKay	Canada	1966	280	12	12.3	--	--	63.6	8.6	85.4
Mills	U. S. A.	1966	887	12-18	68.9	--	--	4.9	3.9	77.7
Erickson	U. S. A.*	1966	105	12-13	30.4	26.7	1.0	27.7	1.0	59.1
Erickson	U. S. A.**	1966	190	12-13	34.2	33.7	2.6	36.3	0.5	71.1
Scheinn	Finland	1970	394	Adult	64.5	--	--	14.5	6.1	86.0

* Fluoridated Community.
** Non-fluoridated Community.

a high of 95.2% (Ast, 1965), to a low of 42.2% (Adler, 1956). Large disparities in the reported incidence of malocclusion (as judged by Angle's classification) have also been noted by other investigators. Massler and Frankel (1951) attributed this lack of agreement to several factors such as the varied criteria used to assess normal occlusion, the wide range of age groups studied and the small number of individuals examined in some investigations. Horowitz et al (1970) reported that the disparity in results of various studies employing Angle's classification indicated either a geographic variation in prevalence of malocclusion or that this classification was too "subjective and confusing" to be used in the assessment of malocclusion.

In addition to the criticism offered by Massler and Horowitz it should be noted that Angle's classification considers malocclusion as a discrete rather than a continuous variable and is therefore, insensitive to the degree of severity of malocclusion. For these reasons and also because of the desire of investigators to statistically analyze and compare epidemiological data, there has been a search for a more objective and quantitative method of assessing the severity of malocclusion.

Indices of Malocclusion

The desire of investigators to objectively assess the severity of malocclusion and to obtain reproducible, quantitative epidemiological data, has lead to the introduction of numerous indices of malocclusion.

In orthodontics, the index score is a number used to designate the presence and severity of a malocclusion. The use of a continuous numerical scale makes it possible to establish treatment priorities by identifying those individuals with handicapping malocclusions.

Massler and Frankel (1951) were probably the first to introduce a quantitative method of assessing the severity of malocclusion. They used the individual tooth as the unit of occlusion and counted the number of maloccluded teeth in each arch. The resulting score described the severity of malocclusion. Since each malposed tooth, regardless of its degree of malposition, was assigned a value of 1, the range of scores possible was 0 to 28 (third molars were not included). Ideal occlusion was considered to be present when not a single tooth was out of alignment or occlusion. Malocclusion was considered to be present if the investigators felt that the child required orthodontic treatment, or had more than ten malposed teeth.

The 2,758 children which Massler and Frankel examined had a total of 29,103 maloccluded teeth or an average of 10.5 maloccluded teeth per child. Since other epidemiological studies have not been carried out using this classification, comparison of results is not possible. In order to permit a comparison of their data with other studies, they reported the incidence of Angle classes of malocclusion as follows: Class I malocclusion 50.1%; Class II 19.4% and Class III 9.4%. In all, 79% of those examined exhibited some form of malocclusion. Their most striking finding seems to be the rather high incidence of Class III

malocclusions.

The Facial Orthometer developed by Pelton and Elsasser (1953) was an anthropometric instrument designed to measure dentofacial features in population studies. In order to analyze the measurements recorded, the Dentofacial Index was established. This was based upon the degree of departure of midline facial points from a vertical plane perpendicular to the Frankfort horizontal and dropped through a point twenty millimeters anterior to nasion. Furthermore, the index included the proportion of upper facial height to total facial height and the presence or absence of dental crossbites and crowded arches. To evaluate this index an assessment of malocclusion was conducted on a population of 348 children between the ages of six and thirteen years living in Nampa (a fluoridated area) and Coeur d'Alene (a fluoride free area), Idaho. The results were expressed in terms of the Dentofacial Index, values of which ranged from 0, indicating no malocclusion, to 21, indicating a severe malocclusion. Mean index scores for Nampa and Coeur d'Alene were 4.54 and 4.88, respectively. In evaluating the severity of malocclusion the reported index scores appear quite low. However, when modified by the fact that 82% of the children of Nampa and 91% of those in Coeur d'Alene exhibited crowding and crossbites (factors not measured in this index), the figures became more realistic. This would emphasize the fact that the Dentofacial Index scores measured with the Facial Orthometer must be augmented with other measurements, such as the degree of crowding and crossbite, in order to give a reasonable assessment of the severity of malocclusion.

The main disadvantage of this index was that it did not define the need for treatment.

In an effort to arrive at a practical method of assigning priorities for orthodontic treatment in a publicly funded program, Draker (1958) developed the index of "Handicapping Labio-lingual Deviations" (HLD). The index score, was derived from a weighted summation of the measurement of the following five dental variables; overjet, overbite, openbite, mandibular protrusion and labio-lingual spread. All measurements were made with a Boley gauge, recorded and rounded off to the nearest millimeter.

The method of measuring the components included in this index was as follows (after Draker, 1958):

Overjet This was measured with the patient in centric relation and applied to a protruding single tooth or a whole arch.

Overbite A pencil mark was placed on the tooth indicating the extent of overlap. It was measured and rounded off to the nearest millimeter. Reverse overbite, as in an anterior crossbite, may exist and should be measured and recorded.

Mandibular Protrusion This was measured from the labial of the lower incisor to the labial of the upper incisor.

Openbite This condition was defined as the absence of occlusal contact in the anterior region. It was measured in millimeters, from incisal edge of upper incisor to the incisal edge of the lower incisor.

Labio-lingual Spread To measure this variable the Boley gauge was used to determine the extent of dental deviation from the normal arch form. The distance between the most protruded and lingually displaced anterior tooth was measured. Only the most severe individual measurement was included in the index.

This index included two additional components. Cleft lip or palate and severe traumatic deviations. Either of these conditions automatically resulted in the designation of the child as "handicapped".

According to Draker (1958), the average time needed for each examination was three minutes and the results proved to be reproducible in a great percentage of cases. Draker (1970) also examined the validity of peer judgement as opposed to the use of the Handicapping Labio-lingual Deviation Index in the assessment of malocclusion. His results did not support the view that clinical judgement was the best method of assessment because the individual examiner's subjective assessment was too variable.

Ast, Carlos and Cons (1965) employed the Handicapping Labio-lingual Deviation Index to assess the severity of malocclusion in a sample of 1,413 children between the ages of fiteen and eighteen years. These investigators reported that 14.4% of those examined had a severe potentially handicapping malocclusion as judged by an index score of 14 or greater.

In an effort to improve Pelton and Elsasser's (1953) method of assessing malocclusion, Van Kirk and Penell (1959) presented an objective clinical assessment index which scored any deviation from the normal alignment of teeth. Measurements were carried out using a plastic instrument designed by these investigators. Each tooth was given a score of 0, 1 or 2, depending on the amount it deviated from the ideal arch form and the final index score was arrived at by totalling

the value given to each tooth. The severity of malocclusion was rated as slight if the index score fell between 0-5, mild in the 6-9 range, and a score of 10 or greater indicated a moderate to severe condition.

After examination of 152 boys they reported mean index scores of 6.9 for twelve year olds and 8.3 for fifteen year olds. Although cross sectional in nature, this study tended to indicate an increase in the severity of malocclusion with age.

The major draw back to Van Kirk and Penell's index was that it was carried out with the mouth open and therefore index scores were not affected by the relationship of the maxilla to the mandible.

The Treatment Priority Index developed by Grainger (1966) was an outgrowth of the Burlington Orthodontic Research Centre. This index incorporated several occlusal measurements which could be carried out in a clinical examination of the patient or on a set of dental models. The basis of this index was a study of the relationship between occlusal disorders as they occurred in 375 twelve year old children who had no history of orthodontic treatment. This group constituted a representative sample of children from three Ontario communities. The index was then developed by defining the natural groupings of manifestations which tended to occur jointly and which were referred to as syndromes, this was followed by a regression analysis to determine weighting factors appropriate to each syndrome. These syndromes were derived from the results of factorial analyses. The variables comprising these syndromes were the antero-posterior relationship of the first permanent molars,

the overjet or underjet, the overbite or openbite, the number of teeth rotated or displaced, posterior crossbite and congenitally missing incisors. The definition and method of measuring these manifestations of malocclusion was as follows (after Grainger, 1966):

Horizontal Incisor Relationship This was recorded as either a positive value indicating an overjet where the maxillary incisors protruded beyond the lower incisors in the horizontal direction, or as a negative value (underjet) when the mandibular incisors protruded beyond the maxillary incisors. It was recorded as a mean of the right and left central incisor and was measured in millimeters from the labial surface of lower incisors to labial incisal tip of upper incisor or the reverse.

Vertical Incisor Relationship

i) Overbite This was measured as an average of the two central incisors and was recorded in thirds of the lower incisor crown.

ii) Openbite This was measured in millimeters at right angle to the occlusal plane.

Congenitally Missing Incisors Incisors were considered congenitally missing if they were not clinically visible.

Antero-posterior Buccal Segment Relationship This was recorded as either distocclusion, neutroclusion or mesioclusion and represented the antero-posterior relation of the maxillary and mandibular first permanent molars. For each side, the degree of deviation from neutroclusion in terms of cusp units was observed. If the displacement on a side was such that the lower tooth cusp fits into the upper groove to the posterior of its normal position, the score was 2 for distoclusion on that side. If the lower tooth cusp fits into the groove to the anterior of the normal position, 2 was scored for mesioclusion. For partial displacement in either posterior or anterior direction such that the cusps did not fit into the grooves but were roughly halfway or cusp to cusp, 1 was scored for distoclusion or 1 for mesioclusion. The scores for each side were added to give a single score.

Posterior Crossbite Disregarding single tooth malposition, the number of teeth involved in a posterior arch crossbite was recorded. The crossbite was judged as buccal or lingual according to the position of the upper teeth to the lower teeth. The true underlying cause, that is, which arch was really displaced, was ignored.

Tooth Displacement The number of teeth rotated or displaced was recorded. A score of 1 was given for each tooth with a minor degree of rotation (45 degrees or less) or malposition (2 mm or less) and a score of 2 for teeth in major rotation (greater than 45 degrees) or displaced farther than 2 mm.

It should be noted that malposition of the teeth was only recorded when they interferred with or did not serve normal function. For example, crossbites, over eruption, ectopic eruption and transposition. Minor malpositions were ignored. This method of scoring deviations was based on the work of Van Kirk and Penell (1959).

The Treatment Priority Index was tested for validity by Summers (1966) and found to be "biologically and clinically" pertinent for children twelve years of age. The reproducibility and the ranking of malocclusion were considered within tolerable limits. MacKay (1966) employed this index to assess the severity of malocclusion in a group of 280 twelve year old children. He found that 85.4% of the children had some form of malocclusion and that 18.7% of those examined were in serious need of orthodontic treatment as assessed by an index score of 7 or greater.

In an attempt to develop an index which could be used to assess the severity of malocclusion in children of varying stages of dental development, Summers (1966) presented the Occlusal Index. This was based almost entirely on the Treatment Priority Index with the only additions being dental age, degree of posterior crossbite, posterior openbite, midline relations and displacement of teeth by cause. These

modifications were intended to improve the validity of the index during the mixed dentition stage of development and were of questionable improvement for assessing the degree of malocclusion in children with permanent dentitions (Popovich, 1971).

Summers (1966) assessed the severity of malocclusion in a group of 390 children using the Occlusal Index. He found that 40% of the children examined required some form of orthodontic treatment and that 21% of the total sample were in need of definite orthodontic treatment with 6% of these classified as having severe occlusal disorders.

The Malocclusion Severity Assessment Index was developed by Salzmann in 1967 for use in epidemiological studies and in regions where treatment priorities needed to be established. Comprehensive survey sheets have been printed and are available from the American Association of Orthodontists; which in fact, has officially approved this index. The variables scored in this index were as follows; crossbite, antero-posterior molar relationship, missing teeth, crowded teeth, rotated anterior teeth, rotated posterior teeth, spacing and incisor overjet and overbite. The strongest point in favor of this index is that it provides a method for scoring intra-arch spacing and crowding although no quantitative measurements are made. Although this index has been accepted by most American Dental Associations it is currently undergoing field testing in the New York State Area (Allen, 1971). Because of this, no figures on severity, incidence or treatment needs have been reported by investigators using this index.

A review of literature has indicated that, although numerous indices of malocclusion have been proposed, none has as yet gained the acceptance of clinicans or epidemiologists. However, according to Carlos (1970) at least three indices; the Handicapping Labio-lingual Deviation Index (Draker, 1958), the Treatment Priority Index (Grainger, 1966) and the Malocclusion Severity Assessment Index (Salzmann, 1967) are currently in use. Since the validity and usefulness of any one of these remains to be established, the action which the American Association of Orthodontists has taken to support and encourage the use of the Malocclusion Severity Assessment Index seems premature.

Incisor Relationship

Keith (1929) has presented anthropologic evidence revealing that the upper and lower incisor teeth in primitive man occluded end to end; in fact, it was not until the time of the Saxons, just over 1,000 years ago, that vertical overbite became prevalent.

In contemporary literature, the term overbite describes the vertical distance which the maxillary incisal edge overlaps the mandibular incisal edge when the posterior teeth are in maximum occlusion. Overjet refers to the horizontal measurement between the lingual aspect of the maxillary incisors and the labial surface of the mandibular incisors when the teeth are in maximum occlusion. Openbite, is used to describe the condition which exists when a space is present between the occlusal or incisal surfaces of maxillary and mandibular teeth when the teeth in

the buccal segments are in maximum occlusal contact. The opposite of this would be the deep bite; that is, a condition of excessive overbite.

It is generally acknowledged in the literature that some degree of overbite and overjet is normal. While the measurement of overjet is almost universally carried out using a millimeter measure; there are at least three methods of measuring overbite. Bjork (1953) and Lundstrom (1960) measured overbite in millimeters of lower crown covered by upper incisor while Grainger (1966) and Summers (1966) recorded overbite as a ratio of thirds of the lower crown covered by the upper incisor. Moorees (1959) indicated the degree of overbite as a percentage of lower central incisor covered by upper central incisor.

Because of the variability in clinical crown size of both the maxillary and mandibular incisors, the ratio or percentage method of measuring overbite is preferred. Each of these methods, however has been employed and reported in the literature making comparison between studies difficult.

Bjork (1953) examined the incisor relationship of a random sample of 322 twelve year old boys and reported mean values for overjet of 4.1 mm and for overbite 2.6 mm. Flemming (1961) recorded the overbite on a sample of 74 twelve year old children with Class I occlusions, and reported a mean overbite value of 4.37 mm. Fulton (1965) reported a mean overjet of 3.18 mm and a mean overbite of 3.24 mm in a group of 977 children between the ages of ten and nineteen years. He found no

significant differences between the sexes. Summers (1966), investigating a group of 96 twelve year old children, reported a mean overjet of two to three millimeters and an overbite of zero to one-third of the lower incisor crown, with no significant differences between males and females.

It should be noted that Fleming (1961), Fulton (1965) and Summers (1966) reported no significant differences in overbite or overjet between the sexes. There does, however, appear to be significant differences in the reported degree of overjet and overbite between studies.

Profile Analyses

In order to determine the full impact of a malocclusion on an individual, consideration must be given to the effect imposed on the facial structures. The degree to which occlusal disharmony and facial asymmetry are linked has been expressed by both Angle (1907), and Elsasser (1951), who attempted to determine methods to ascertain the degree of relationship between the two. Anthropometry was the first method used to study profile form with Camper (1768) being cited by Riedel (1948) as the first investigator to employ angular measurements in the analysis of facial form. Hellman (1927), more than anyone else must be given the most credit for applying anthropometric principles to orthodontics when, nearly forty-five years ago he employed this science in studies relating the facial structures to the dentition.

A soft tissue anthropometric technique was devised by Simon (1926).

This method employed three planes: Frankfort horizontal, the orbital plane, and the median sagittal plane. The head was thus divided and the dentition related to these planes. A photographic analysis technique was subsequently developed in which the Frankfort and orbital planes were drawn on the subject's photograph. A quadrilateral figure was constructed by drawing a line from the "ear point", or tragus, to gonion and thence to gnathion. The relationship of certain profile and cranial points to these planes were studied. In more recent years Burstone (1958) and Subtelny (1959) have employed radiographic cephalometry to investigate both skeletal and soft tissue morphology.

In spite of the usefulness of cephalometric radiography in clinical investigations and growth studies, it's use in epidemiological investigations of school children is considerably limited. This is because of the bulky equipment required and the parental consent necessary before radiographic examination is permitted.

Photographic Analyses

In recent years there appears to be an increased use of photographs in both clinical and research investigations. While clinicians use photographs primarily in a subjective manner as a diagnostic aid and to demonstrate facial changes at the completion of orthodontic treatment (Tweed, 1968); research investigators have begun to quantitate various photographic soft tissue measurements and establish standards representative of individuals with good facial form and balance, as was done

when cephalometric radiographic analyses were first introduced by Downs (1948).

A photometric analysis of the facial profile was introduced by Stoner (1955) as a method of assessing facial changes induced by orthodontic treatment. This analysis was based on the Frankfort horizontal and facial planes which were employed to relate the soft tissue nasion, pogonion, and upper and lower lips. Two groups of facial photographs were examined. The first consisted of thirty-four children with "excellent facial form and balance"; the second consisted of fifty children consecutively treated by Stoner. Because of the large range found for each measurement, the treated group had to be assessed on the basis of the range of measurements found in the "excellent face" group, rather than by comparing individual measurements or their mean values for these two groups. Stoner found little difference in the range of the facial plane angle between these groups and concluded that the chin position was of little value in determining facial profile harmony.

Ricketts (1957) related the lips to the "esthetic plane", a line drawn from the tip of the nose to the chin. With this as a basis he formulated his law of lip relationship which stated that by adulthood the lips should be contained within this esthetic plane. The advantage of this method of assessing facial harmony was that it was a simple yet relatively accurate method of determining the relationship of the nose, lips and chin to each other.

Bash (1958) developed a quantitative method of describing changes

in the soft tissue profile due to growth and variations of orthodontic treatment. His plane of reference was the "profile determinant plane" which was established from soft tissue glabella to soft tissue pogonion. Soft tissue points were then related to this plane by measuring their perpendicular distance from the plane; points anterior being designated as plus values and those posterior as minus values. Bash found that as a result of treatment and growth there was a reduction of the procumbency of the soft tissues about the dento-alveolar areas and a straightening of the profile.

Powell (1964) developed a soft tissue analysis which considered the prominence of the nose, lips and chin. Reference planes were constructed from soft tissue nasion to pogonion and from tip of nose to soft tissue pogonion. The angle formed by these planes was bisected by a third plane. Linear measurements were then recorded to determine the antero-posterior position of the lips in relation to this bisected plane. The sample Powell studied consisted of three groups. Group I included 56 fourteen year old children with pleasing profiles as determined by orthodontists; group II consisted of 43 twelve year old orthodontic patients; and group III consisted of 22 young women who were former beauty contestants. The findings of this study indicated that in those subjects with good facial esthetics the upper and lower lips lie approximately .5 mm anterior to the bisecting line, whereas in the case of the orthodontic patients the lips were anterior to this line a distance of 5.6 mm for the upper lip and 4.28 mm for the lower lip.

The quantitative method of evaluating the soft tissue facial profile introduced by Neger (1959) made use of profile photographs with soft tissue landmarks drawn directly on the prints. Planes of reference were constructed from soft tissue nasion to labrale superius, labrale inferius and soft tissue pogonion. The intersection of these lines with Frankfort plane formed three angles which were termed profile angles. Measurements were made of the angles formed by the intersection of these lines to each other. In this way the soft tissue landmarks were related to each other.

Using this analysis, Neger compared the photographic profiles of two groups. The first consisted of children with "clinically excellent faces"; while the second was composed of children with Angle Class II and Class III malocclusions. After analyzing the photographic measurements and comparing the results, Neger concluded that straight profiles did not necessarily accompany normal occlusion.

Peck and Peck (1970) devised a photographic Profilometric Analysis to objectively assess the facial profile. Seven angular measurements were made on oriented head photographs using the following soft tissue landmarks; nasion, pronasale, labrale superius, pogonion and tragion. The sample investigated was composed primarily of female models, beauty contest winners and entertainment personalities. On the basis of this analysis, Peck and Peck concluded that their sample exhibited a more protrusive dento-facial pattern than was usually accepted by cephalometric standards. Since the position in society which these individuals hold

was determined by public endorsement, it was felt that the average person admired a fuller and slightly protrusive dento-facial pattern. These findings were not in agreement of those of Peay (1956).

Peay (1956) submitted photographs of thirty-two female beauty contest winners to forty orthodontists to be judged by inspection as "good", "fair" or "poor" faces. Various measurements were taken of lateral cephalometric head films using the Downs (1948), Steiner (1953) and Wylie (1947) analyses. His findings revealed that the most pleasing faces selected by the orthodontists were those which had straight skeletal profile and little if any dental protrusions, the more undesirable faces possessed convex skeletal profiles and greater dental protrusions.

Cox and Van der Linden (1971) examined a sample of individuals who were not preselected on the basis of normal occlusion or facial balance. This group consisted of 241 female and 186 male university students. Facial harmony was assessed by having ten orthodontists and ten laymen subjectively assess the silhouette photographs of each individual. In addition, cephalometric and model analyses were carried out. As a result of this investigation Cox and Van der Linden concluded that individuals with poor facial esthetics in general have relatively more convex faces with their incisors more anteriorly positioned. It was also observed that the larger degree of facial convexity was due to a more anterior position of the dental, skeletal and soft tissue structures of the middle face. These investigators also noted, as did Neger (1959),

that good facial esthetics could be associated with malocclusions as well as normal occlusions.

It is interesting to note that although numerous investigations have been carried out to quantitatively analyze the soft tissue profile, no one to date has suggested that a facial photographic index be established. If this were done it would be possible to assess facial proportions by means of a single index score.

Prepaid Dental Care

Avnet (1969) noted that prepaid dental care was first introduced in the mid-1950's by the Group Health Dental Insurance Company of New York. By 1960 fewer than one half of one per cent of the population had any form of dental insurance and by 1965 only about one per cent of the population was covered. These figures serve to indicate that although dental insurance is a relatively recent development and still in its infancy, there is a definite growing trend towards prepaid dental plans. One Canadian Insurance Company* indicated that as of 1969 only 600 people in Manitoba carried dental insurance through a group policy. At present, there are no dental plans available for individual policy holders.

The most common type of coverage purchased is for routine dental treatment such as amalgam fillings and extractions, although more exten-

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* The Great West Life Assurance Company.

sive coverage, which includes orthodontic treatment is available. However, because very few dental plans at present cover orthodontic treatment (Reynolds, 1971), there are no statistics available to indicate the effect or utilization of these plans.

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

This study was designed to gather and analyze data relating to various aspects of malocclusion. The sample was composed of 444 twelve-year old Caucasion school children representing approximately 10% of the Winnipeg, Manitoba grade VI school population. The actual survey was preceeded by a pilot study in which thirty orthodontic patients, undergoing treatment at the Faculty of Dentistry, University of Manitoba, were examined. This pilot study was conducted to determine the feasibility of the actual field methods proposed, to estimate the time requirements and to investigate the most appropriate method of recording the field information.

The pilot study revealed that the proposed method of examination was feasible, that an average examination required twelve minutes per child, and that the use of a dental assistant to record information at the time of clinical examination was desirable.

The actual survey was conducted during the six months period, January to June, 1970. The equipment used consisted of a mouth mirror, a dental explorer, a plastic millimeter ruler, a Boley gauge, a 35 millimeter camera*, and a plastic measuring instrument designed by Van Kirk and Penell (1959). The latter was utilized to measure individual

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* PENTAX SPOTMATIC, manufactured by the ASAHI CO., JAPAN.

tooth displacements and rotations.

The Sample

A random sample from fifteen City of Winnipeg, Manitoba public schools was drawn with the aid of random numbers (Fischer and Yates, 1953). In addition, included in the sample were three private schools and four public school dental clinics established by the City of Winnipeg. A complete list of the schools sampled is presented in the Appendix (Table XXXIII).

The examinations were usually conducted in the school health room where adequate lighting was present. Each child was examined separately so that his answers to subjective questions would not be influenced by those of other children.

The director of the dental clinics and the involved school teachers were instructed to send every child between the ages of eleven years six months and twelve years eleven months to the survey room where the examiner made the final selection of children on the basis of dental age. Of the 900 children examined, 444 were retained for the final examination. With the exception of third molars, these children had a full permanent dentition with their cuspids and second molars erupted.

A survey sheet, including the required information as illustrated in Figure 1, was filled out for each child at the time of examination. The twenty-six children found to be receiving orthodontic treatment were not surveyed directly in their schools. Their orthodontists were con-

Survey Sheet

Name _____ Dentist _____

Address _____ Orthodontist _____

Phone _____ Parent's Occupation _____

Date of Birth _____ Place of Birth _____

A Location of Patient
B Study Number
C Age
D Sex
E Occlusion
F Treatment
G Treatment Suggested
H Amount of Positive or Negative Overjet
I Amount of Overbite in mm
J Overbite of Thirds in Lower Crown Covered
K Amount of Open Bite in mm
L Cleft Palate or other Congenital Defect
M Severe Traumatic Deviation
N Congenitally Missing Lateral Incisors
R Number of Teeth Rotated 45° or less or displaced 2 mm or less
S Number of Teeth Rotated 45° or more or displaced 2 mm or more
T Labio-lingual Spread
U Antero-Posterior Relation of First Permanent Molar
V Antero-Posterior Relation of First Permanent Teeth Right Buccal Segment
W Antero-Posterior Relation of First Permanent Teeth Left Buccal Segment
X Posterior Crossbite of Right Buccal Segment
Y Posterior Crossbite of Left Buccal Segment
Z Anterior Cross Bite
a Fluoride (Patient lived for whole life in fluoride area)
b Patient born and lived in Winnipeg whole life
d Any missing permanent teeth

Date of examination (year and month)

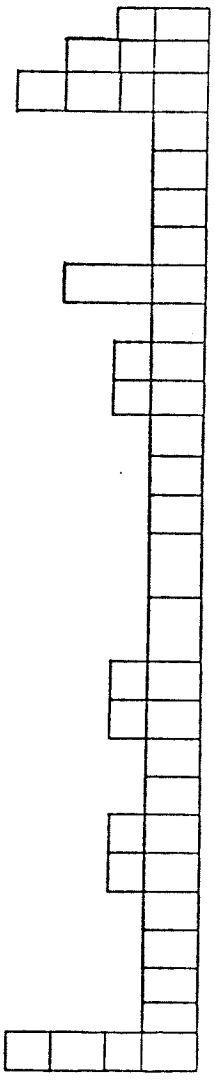

Figure 1. Survey sheet employed in the study.

tacted for pretreatment information in order to complete the child's survey sheet. It must be emphasized that in most instances these pretreatment records were taken at an age less than twelve years.

For each of 290 children selected at random, a lateral black and white photograph was taken, enlarged, and printed on an 8" x 10" sheet of mat paper. Prior to taking these photographs, the soft tissue landmarks nasion and orbitale were marked on the child's face (Figure 2) using a popular brand of mascara. Each child was seated, instructed to look straight ahead, close on his back teeth and relax. Every effort was made to ensure that the subject was in centric occlusion and that, in the absence of a head-holder or ear rods, his head posture was correct so that an accurate lateral photograph would result.

The total sample of 444 children, drawn from the three types of schools surveyed, private, public and clinic, was subgrouped according to sex, occlusion, and socioeconomic level. These schools were considered, for purposes of this study, to be representative of the high, medium, and low socioeconomic levels, respectively.

Children for whom not a single maloccluded tooth could be discovered were considered to have ideal occlusion, those whose degree of tooth displacement was so slight as to require no orthodontic treatment were considered to have acceptable occlusion, while those remaining were considered to have some degree of malocclusion. Due to the absence of any children with "ideal occlusion" there were twelve subgroups as illustrated in Table II.

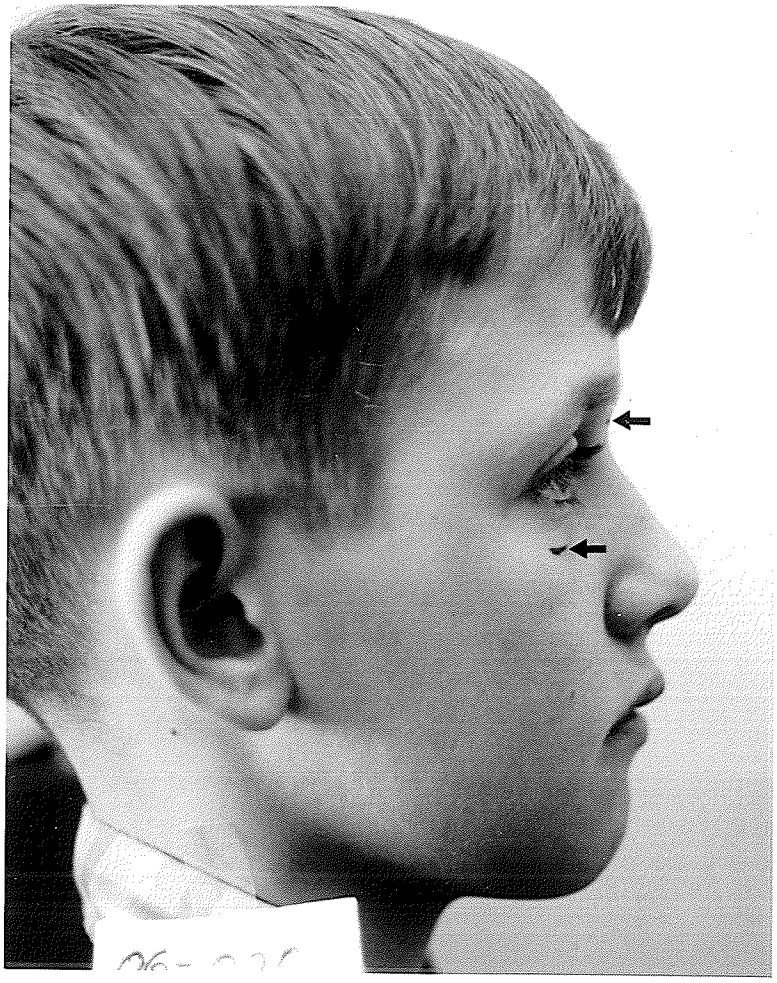

Figure 2. Photograph demonstrating soft tissue nasion (upper arrow) and orbitale (lower arrow).

TABLE II

DISTRIBUTION OF SAMPLE OF 444 CHILDREN ACCORDING TO SEX, OCCLUSION AND SOCIOECONOMIC LEVEL

Sex	Occlusion	Socioeconomic Level	Number of Children
Male	Acceptable	High	5
		Medium	16
		Low	1
	Malocclusion	High	29
		Medium	128
		Low	25
Female	Acceptable	High	2
		Medium	28
		Low	11
	Malocclusion	High	19
		Medium	142
		Low	38
		Total	444

For the 63 children (22 males and 41 females) who were considered to have acceptable occlusion, (Figure 3) additional records were taken at the Faculty of Dentistry, University of Manitoba. These records included a detailed dental examination in which cephalometric radiographs, panoramic radiographs, hand wrist radiographs, dental models and cinefluorographic radiographs were obtained. The information gathered from this examination will be incorporated into another study involving the form and function of children with acceptable occlusion.

Collection of Data

The data recorded on the survey sheet (Figure 1) together with the additional information calculated from it, and the measurements made on the photographs were transferred to standard 80 column IBM cards for further analysis. The survey sheets were designed to include all information required for the calculation of the Treatment Priority Index and the Handicapping Labio-lingual Deviation Index. The variables obtained from the data were classified, for purposes of presentation, into three groups as listed in Tables III, IV and V.

Dental Care Variables

For the purpose of obtaining general dental care and motivation data on the children studied, the following variables (Table III) were

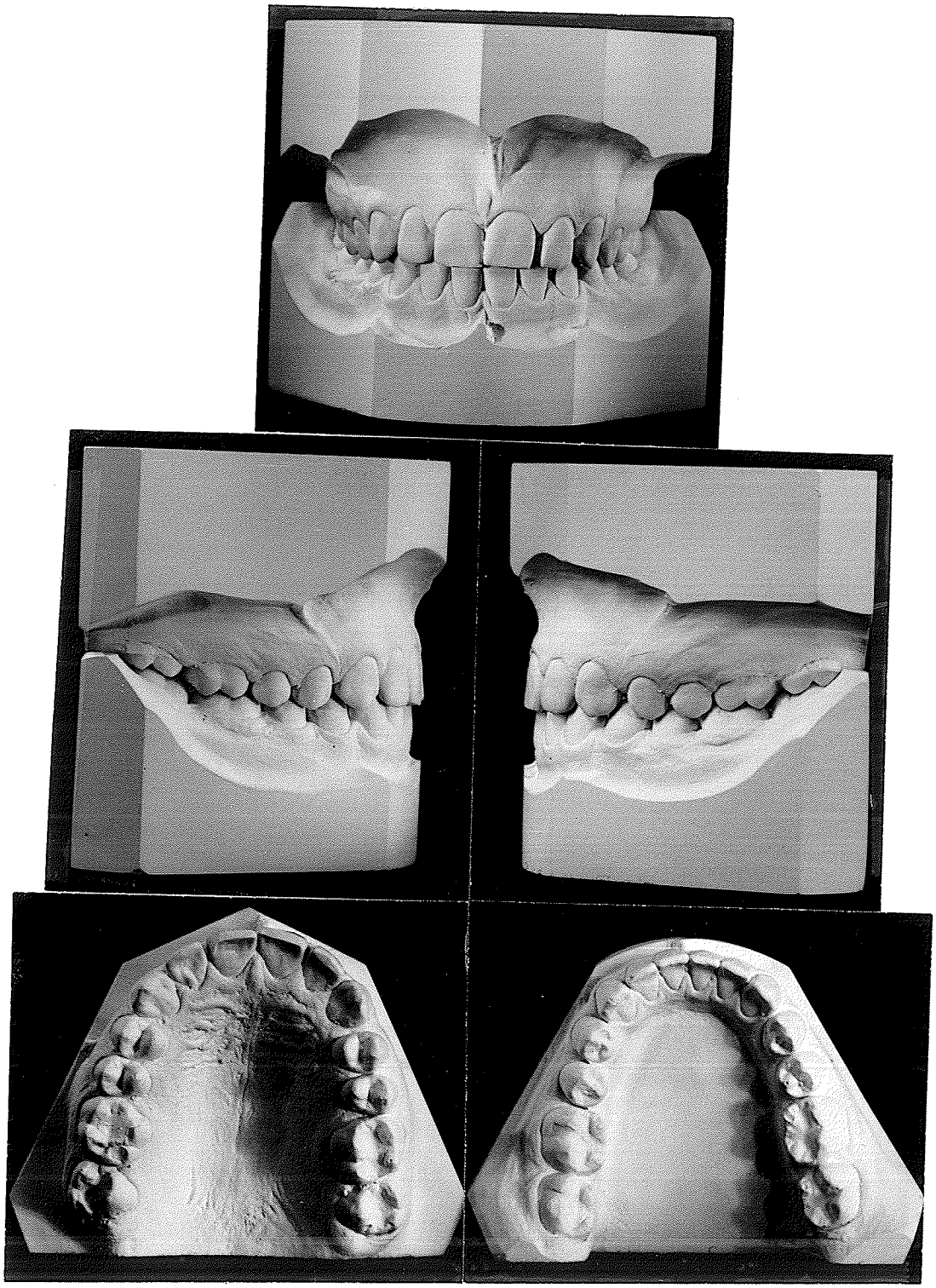

Figure 3. Photographs of plaster models illustrating acceptable occlusion.

TABLE III

DENTAL CARE VARIABLES

Variable Number	Variable Identification	Type of Variable
D_1	Dentist	Discrete
D_2	Orthodontist	Discrete
D_3	Treatment suggested	Discrete
D_4	Fluoridated water	Discrete
D_5	Missing maxillary molars	Discrete
D_6	Missing mandibular molars	Discrete
D_7	Missing lateral incisors	Discrete
D_8	Straight teeth	Discrete
D_9	Would wear braces	Discrete

recorded:

D_1 Dentist: Whether or not the child had a family dentist.

D_2 Orthodontist: Whether or not the child was receiving orthodontic treatment.

D_3 Treatment suggested: Whether or not orthodontic treatment had ever been suggested.

D_4 Fluoridated water: Whether or not the child was reared in a community which had a fluoridated water supply.

D_5 Missing maxillary molars: The number of missing maxillary first permanent molars.

D_6 Missing mandibular molars: The number of missing mandibular first permanent molars.

D_7 Missing lateral incisors: The absence of maxillary lateral incisors were recorded.

D_8 Straight teeth: The child's response to the question; "Do you think your teeth are reasonably straight".

D_9 Would wear braces: The child's response to the question; "Would you wear braces to have your teeth straightened".

Occlusal Variables

The following variables (Table IV) were recorded to enable the calculation of the Treatment Priority Index, Handicapping Labio-lingual Deviation Index, and to obtain information about certain occlusal characteristics in the children examined.

O_1 Angle classification: The Angle classification of malocclusion was assessed using the criteria for classes as described by Angle (1899) and outlined in Chapter II.

O_2 Overjet or underjet: This was recorded in millimeters either as a

TABLE IV

OCCLUSAL VARIABLES

Variable Number	Variable Identification	Type of Variable
O_1	Angle classification	Discrete
O_2	Overjet or underjet (in millimeters)	Continuous
O_3	Overbite or openbite (in millimeters)	Continuous
O_4	Labiolingual spread (in millimeters)	Continuous
O_5	Number of teeth rotated or displaced	Continuous
O_6	Posterior crossbite	Discrete
O_7	Congenitally missing incisors	Discrete
O_8	Cleft lip or palate	Discrete
O_9	Severe traumatic deviation	Discrete
O_{10}	Handicapping Labio-lingual Deviation Index Score	Continuous
O_{11}	Treatment Priority Index Score	Continuous

positive value, indicating an overjet where the maxillary incisors protruded beyond the lower incisors in the horizontal direction, or as a negative value, indicating an underjet, when the mandibular incisors protruded beyond the maxillary incisors. These values were recorded as a mean of the right and left central incisor and were measured in millimeters from the labial surface of the lower incisor to the labial incisal tip of upper incisor or the reverse.

0_3 Overbite or openbite: The overbite was measured in millimeters as described by Draker (1958) and in thirds of lower incisor crown, Grainger (1966). The openbite was measured in millimeters at right angles to the occlusal plane.

0_4 Labio-lingual spread: This was measured in millimeters as the distance between the most protruded and lingually displaced anterior tooth.

0_5 Number of teeth rotated or displaced: As described by Grainger (1966), the number of teeth rotated or displaced were recorded.

0_6 Posterior crossbite: The number of teeth involved in a posterior arch crossbite was recorded as outlined by Grainger (1966).

0_7 Congenitally missing incisors: The absence of lateral incisors was recorded.

0_8 Cleft lip or palate: The presence of this deformity was recorded.

0_9 Severe traumatic deviation: This was recorded as outlined by Draker (1958).

0_{10} Handicapping Labio-lingual Deviation Index: Variables 0_2, 0_3, 0_5, 0_6 and 0_7 were used to calculate this index for each child using an especially designed computer program* based on the method described by Draker (1958), and outlined in Chapter II.

0_{11} Treatment Priority Index: Variables 0_1, 0_2, 0_3, 0_5, 0_6 and 0_7 were used to calculate this index for each child using an especially designed computer program* based on the method described by Grainger (1966) and outlined in Chapter II.

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* These programs were designed by the section of Biostatistics, Faculty of Dentistry, University of Manitoba, under the direction of Dr. F. Chebib.

Photographic Analysis Variables

A photographic analysis was included in the study in an effort to establish an index based on data obtainable from a quantitative analysis of lateral facial photographs. The eleven facial or soft tissue landmarks selected are illustrated in Figure 4 and defined in the Glossary. Thirteen angles were measured and lip posture was recorded as being open or closed. Each photograph was examined by four orthodontists independently. In response to the following question, "From an orthodontic point of view to the soft tissue structures, suggest any skeletal or dental dysplasia?". The examiner scored each child as having a good (=0) or poor (=1) facial harmony.

The following is a description of the fifteen variables (listed in Table V) calculated from an analysis of the photographs.

P_1 and P_2 These are two facial angles relating the anteroposterior position of the mandible to the upper face.

P_3, P_4 and P_5 These angular measurements indicate the degree of facial convexity.

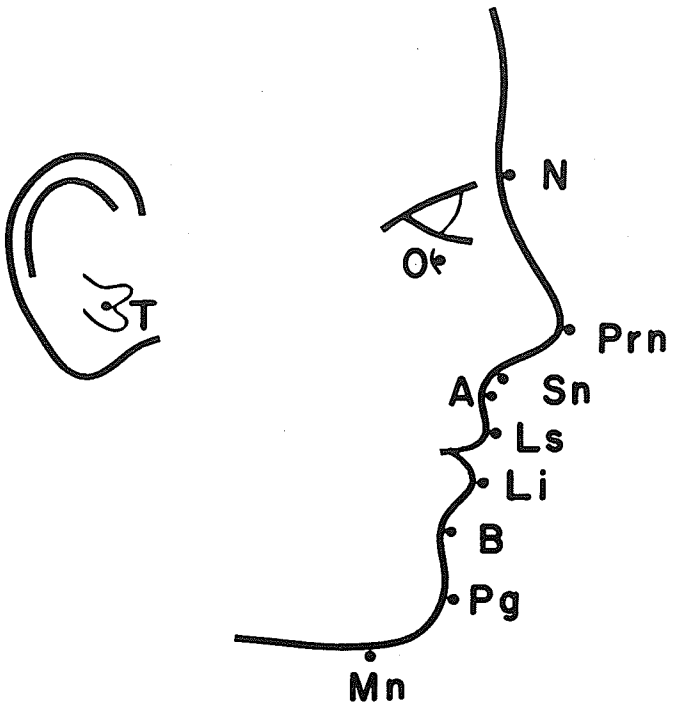
P_6, P_7, P_8 and P_9 These angular measurements indicate the position of the upper and lower lips in relation to themselves, the chin, the nose and the facial plane.

P_{10} This variable gives an indication of the size of the nose.

P_{11} This angular measurement indicates nasal height from nasion to pronasale.

P_{12} This angle measures the maxillary height from pronasale to labiale superius.

P_{13} This angle measures the mandibular height from labrale superius to pogonion.



SOFT TISSUE

N - NASION
O - ORBITALE
Prn - PRONASALE
Sn - SUBNASALE
A - A POINT
Ls - LABRALE SUPERIUS
Li - LABRALE INFERIUS
B - B POINT
Pg - POGONION
Mn - MENTON
T - TRAGUS

Figure 4. Diagramatic illustration of the soft tissue landmarks employed in the photographic analysis.

TABLE V

PHOTOGRAPHIC VARIABLES

Variable Number	Variable Identification	Type of Variable
P_1	Angle (lower inside) formed between line TO and N-P_g	Continuous
P_2	Angle T-P-P_g (P is midpoint of N-Pg)	Continuous
P_3	Angle formed between lines AB and N-P_g	Continuous
P_4	Angle ANB	Continuous
P_5	Angle ANPg	Continuous
P_6	Angle formed between lines L1-P9 and N-P_g	Continuous
P_7	Angle formed between lines Li-Ls and N-P_g	Continuous
P_8	Angle Ls-N-P_g	Continuous
P_9	Angle formed between lines Prn-Ls and T-P	Continuous
P_{10}	Angle N-Prn-P_g	Continuous
P_{11}	Angle N-T-Prn	Continuous
P_{12}	Angle Prn-T-Ls	Continuous
P_{13}	Angle Ls-T-P_g	Continuous
P_{14}	Lip posture	Continuous
P_{15}	Total Photographic Score	Continuous

P_{14} The lip posture was recorded as being open or closed.

P_{15} The total photographic index was the sum of the four examiners scores. Examples of children with high, medium and low photo scores, representing poor, average and good facial harmony, are presented in Figure 5.

Statistical Analysis

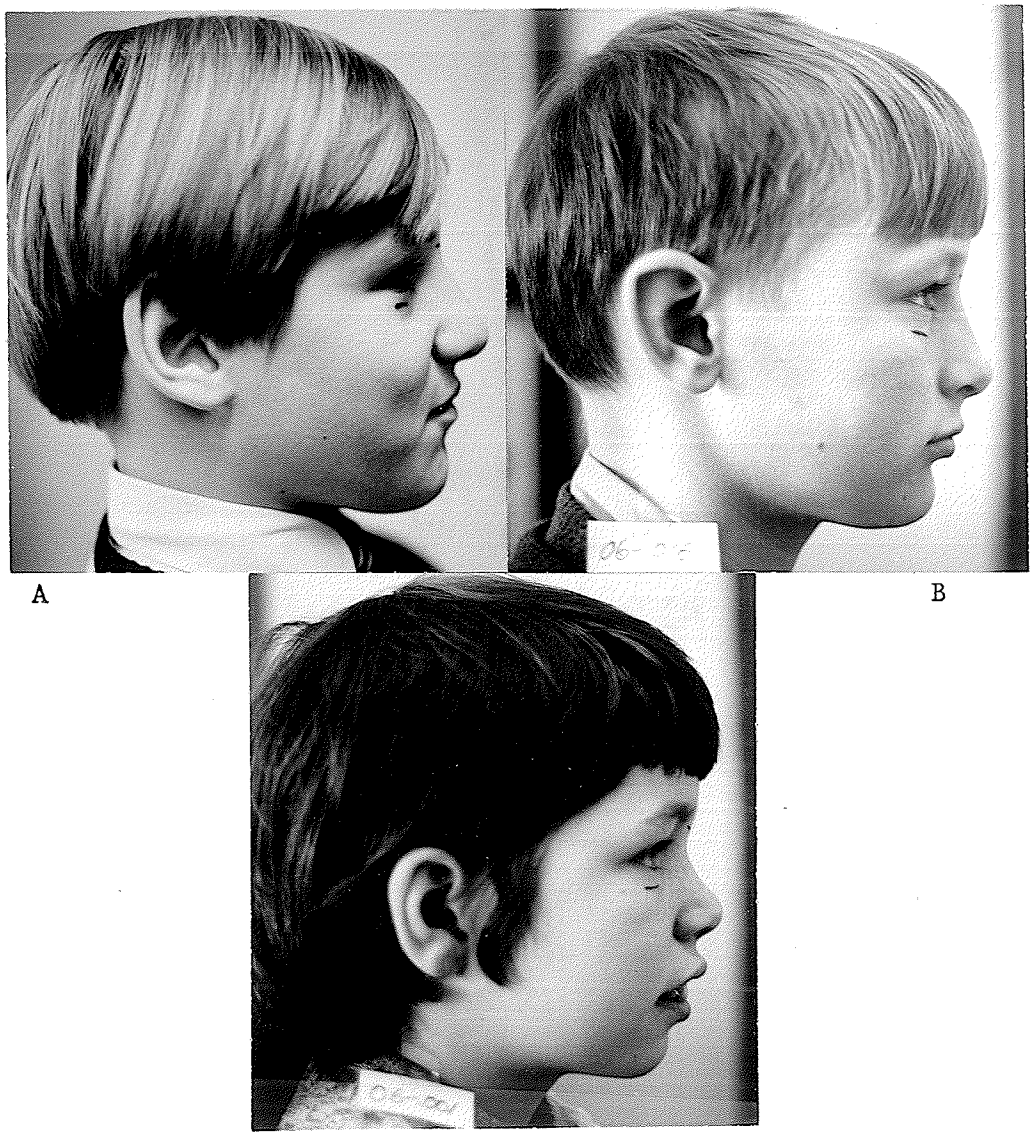
It was recognized that the data collected in this study included discrete and continuous variables (Tables III, IV and V) and the methods of analysis were determined accordingly.

Discrete Variables

For each of the discrete variables three 2-way tables were constructed to indicate its relationship with each of the major classifications namely, sex, occlusion and socioeconomic level. These two-way tables were subjected to a contingency chi square analysis to reveal significant relationships between that variable and each of the three major classifications.

Continuous Variables

Each of the continuous variables was subjected to a 3-way factorial analysis of variance, the factors being sex, occlusion and socioeconomic level. The allocation of degrees of freedom was as follows:



A B C

Figure 5. Examples of children with
A. Good facial esthetics: Photo Index score 0-1
B. Average facial esthetics: Photo Index score 2
C. Poor facial esthetics: Photo Index score 3-4

Source of Variation	Degrees of Freedom
Sex	1
Occlusion	1
Socioeconomic level	2
Sex x occlusion	1
Sex x socioeconomic level	2
Occlusion x socioeconomic level	2
Sex x occlusion x socioeconomic level	2
Within subgroup (error)	432
Total	444

Due to the unequal and disproportionate subclass numbers the mean squares were adjusted by the use of the Harmonic mean method as outlined by Snedecor and Cochran (1967).

All main effects and interactions were tested for significance by an F ratio against the mean square of the pooled within subgroups error.

Simple Correlations

To determine the interrelationships between variables, Pearson product moment correlation coefficients were calculated for all possible pairs of 23 selected variables. These correlations were calculated from the available data obtained through the examination of the 444 children included in this study. The actual sample size was 290 for correlations involving the photographic analysis and 444 for all remaining pairs of variables.

Multiple Regression

The total photographic score (P_{15}) was considered a standard and was treated as the dependent variable in a multiple regression analysis. The independent variables were the photographic variables P_1-P_{14}. The object of this analysis was to devise a formula or index which would allow a photo score to be calculated from a set of measured variables. The regression analysis indicated that only four of the fourteen independent variables bore a significant relation to the dependent variable. This analysis was therefore repeated using, as independent variables, only those variables which showed a significant effect on the total photo score.

Measurement Error

In order to estimate the degree of error committed in the measurement of the various photographic angles, seven children, selected at random, were each photographed twice, three weeks apart; the method being as in the survey. The two sets of photographs were analyzed separately and the duplicate values for each of the thirteen angles were used to determine the measuring error associated with each angle. The mean error was calculated as the mean absolute difference between the two duplicate measurements as follows:

$$\bar{d} = \frac{\Sigma |X_1 - X_2|}{N}$$

It was noted (Table VI) that the measurement error varied with the angle measured, the largest mean error, however, did not exceed 1.29 degrees.

TABLE VI

MEANS AND MEAN MEASUREMENT ERRORS FOR EACH OF 13 PHOTOGRAPHIC VARIABLES

Photographic Variable	Mean	Mean Error
P_1	79.86	.86
P_2	93.64	.71
P_3	15.57	.86
P_4	9.50	.43
P_5	8.50	.43
P_6	13.60	1.29
P_7	14.80	1.00
P_8	8.70	.57
P_9	113.80	.71
P_{10}	131.50	1.00
P_{11}	19.50	.71
P_{12}	13.60	.14
P_{13}	19.20	1.00

RESULTS

CHAPTER IV

RESULTS

The results are presented in four sections: Part I deals with the dental care variables (D_1 to D_8); Part II deals with the occlusal variables (O_o to O_{11}); Part III with the results of the indices of malocclusion; and Part IV with the results of the photographic variables, which lead to the development of a photographic index. The raw data and complete statistical tables will be found in the Appendix, with shortened versions of these tables presented in this section for explanatory purposes.

Dental Care Variables

The results of dental care variables are presented for the total, sample in Table VII and for each of the three major classifications studied, namely sex, occlusion and socioeconomic level, in Tables VIII, IX and X, respectively. Since each of the variables may assume two conditions; for example, having a dentist or not having a dentist, the figures presented in Tables VII, VIII, IX and X are for the positive alternative only.

Table VII shows the number and percentage of each of the dental care variables examined. All percentages were calculated on the basis of the total sample of 444 children. It is noted that approximately 56% of the children examined claimed to have a family dentist and that almost 75% had lived in an area with a fluoridated drinking water supply.

TABLE VII

NUMBER AND PER CENT OF CHILDREN FOR EACH OF NINE DENTAL CARE VARIABLES

Variable	Number (N=444)	Per Cent
D_1 Dentist	251	56.3
D_2 Orthodontist	28	6.3
D_3 Treatment suggested	53	12.0
D_4 Fluoridated water	329	74.1
D_5 Missing maxillary molars	8	1.8
D_6 Missing mandibular molars	22	4.9
D_7 Missing lateral incisors	12	2.7
D_8 "Straight" teeth	216	48.6
D_9 Would wear braces	115	25.9

Only 4.9% of the children had lost one or more mandibular molars. Almost 50% of those examined felt they had "straight" teeth and 25% said that they would wear "braces" to have their teeth straightened.

The percentages shown in the two-way tables VIII, IX and X, are based on the subsample size at the level of the major classification studied, for example, male and female. The calculated contingency chi square values between the variables in question and the major classification studied are also presented with their significance levels.

Table VIII shows the distribution of dental care variables according to sex. It is noted that, with the exception of the number of missing mandibular first permanent molars and the number of children who would wear braces, there were no significant differences between the sexes. It was found that only 1% of the males were missing mandibular first permanent molars as compared to 8.3% of the females. In response to the question, would you wear braces?, girls indicated a greater willingness than did boys.

Table IX indicates the distribution of dental care variables according to occlusion. It is noted that only 7.4% of those classed as having a malocclusion were being treated by an orthodontist. The acceptable and malocclusion groups differed significantly according to five variables yielding the following results. A significantly greater percentage of children in the acceptable occlusion group claimed to have a dentist. There were no children with acceptal occlusion who had lost mandibular molars, while 22 of the malocclusion group were so classified.

TABLE VIII

NUMBER AND PER CENT OF CHILDREN FOR EACH OF NINE DENTAL CARE VARIABLES BY SEX

Variable	Male (N=204)		Female (N=240)		Contingency Chi Square
	Number	Per cent	Number	Per cent	
D_1 Dentist	118	57.8	133	55.4	.58
D_2 Orthodontist	10	4.9	18	7.5	1.29
D_3 Treatment suggested	21	10.3	32	13.4	1.00
D_4 Fluoridated water	149	73.0	180	75.0	.69
D_5 Missing maxillary molars	4	2.0	4	1.6	.06
D_6 Missing mandibular molars	2	1.0	20	8.3	12.69***
D_7 Missing lateral incisors	5	2.5	7	2.9	.08
D_8 "Straight" teeth	108	52.9	108	45.0	3.56
D_9 Would wear braces	42	20.5	73	30.4	3.84*

*** Significant at the .1% level.
* Significant at the 5% level.

TABLE IX

NUMBER AND PER CENT OF CHILDREN FOR EACH OF NINE DENTAL CARE VARIABLES BY OCCLUSION

Variable		Acceptable Occlusion (N=63)		Malocclusion (N=381)		Contingency Chi Square	
		Number	Per Cent	Number	Per cent		
D_1	Dentist	42	66.0	209	54.8	5.61	*
D_2	Orthodontist	0	0	28	7.4	200.00	***
D_3	Treatment suggested	0	0	53	13.9	3.62	
D_4	Fluoridated water	50	79.3	279	73.2	3.62	
D_5	Missing maxillary molars	0	0	8	2.18	1.40	
D_6	Missing mandibular molars	0	0	22	5.7	4.10	*
D_7	Missing lateral incisors	0	0	12	3.20	2.06	
D_8	Straight teeth	51	80.9	165	43.3	25.35	***
D_9	Would wear braces	5	7.9	111	29.1	23.37	***

* Significant at the 5% level.
*** Significant at the .1% level.

It was found that children in the acceptable occlusion group were quite aware that they had straight teeth. As expected a significantly fewer number of children in this group accepted the idea of wearing braces.

Table X shows the distribution of dental care variables according to socioeconomic level. It is noted that with the exception of fluoridated water and missing lateral incisors, all variables examined revealed a significant chi square value. For variable D_1, dentist, it must be pointed out that although 100% of the low socioeconomic group were classified as having a dentist, all these children were seen at the dental welfare clinic.

The general trend indicates that the higher the socioeconomic level, the more likely a child is to have a dentist, to have an orthodontist, to have had treatment suggested, and the less likely it is for him to have had a first permanent molar, either maxillary or mandibular, extracted. A significantly greater number of children in the high socioeconomic group indicated that they would wear braces as compared to both the medium and low groups. On the other hand, a greater number of children in the lower and medium socioeconomic groups indicated that they felt they had straight teeth.

Occlusal Variables

The results of the analyses of occlusal variables are presented in three parts; Angle's classification (variable O_1), Continuous variables O_2, O_3, O_4, O_5, O_{10}, O_{11} and Discrete variables O_6, O_7, O_8 and O_9.

TABLE X

NUMBER AND PER CENT OF CHILDREN FOR EACH OF NINE DENTAL CARE VARIABLES BY SOCIOECONOMIC LEVEL

Variable	Socioeconomic Level: High (N=55) Number	High (N=55) Per cent	Medium (N=314) Number	Medium (N=314) Per cent	Low (N=75) Number	Low (N=75) Per cent	Contingency Chi Square
D_1 Dentist	52	94.5	199	63.4	75	100.0	18.9***
D_2 Orthodontist	10	18.2	17	5.4	1	1.3	16.6***
D_3 Treatment suggested	17	31.0	32	10.2	4	5.3	22.1***
D_4 Fluoridated water	37	67.3	240	76.4	52	69.3	1.9
D_5 Missing maxillary molars	0	0.0	4	1.3	4	5.4	6.6**
D_6 Missing mandibular molars	0	0.0	26	8.2	6	8.0	6.2*
D_7 Missing lateral incisors	2	3.6	10	3.2	0	0.0	2.7
D_8 "Straight" teeth	23	41.8	153	48.7	40	53.3	4.5*
D_9 Would wear braces	23	41.8	73	23.2	19	25.3	7.6**

* Significant at the 5% level.
** Significant at the 1% level.
*** Significant at the .1% level.

Angle's Classification

A detailed distribution of the sample according to Angle's classification is shown in the Appendix (Table XXXIV) for the total sample, each of the sexes and the three socioeconomic levels. The major divisions of Angle's classification are presented in Table XI together with the results of the contingency chi square test.

It is noted that only 14% of the children examined were classified as having acceptable occlusion. There was almost an equal distribution between Class I (36%) and Class II (40%) malocclusion, while Class III accounted for only 3.8% of those examined. In several instances it was not possible to determine the Angle classification either because of a multilated dentition or because the child was undergoing orthodontic treatment and initial records were not available. Since no significant differences were found in the distribution of the various Angle classes of malocclusion for either sex or socioeconomic levels, the results described for the total sample may be applicable to both males and females and to each of the high, medium and low socioeconomic groups.

Continuous Occlusal Variable

Table XII shows the means and standard errors for each of the continuous occlusal variables O_2, O_3, O_4, O_5, O_{10} and O_{11} for the total sample and for each level of the three main effects studied, namely; sex, occlusion and socioeconomic level. The significant differences revealed by the analysis of variance for all continuous occlusal variables are presented in the Appendix (Table XXXVIII). Significant main

TABLE XI

INCIDENCE OF VARIOUS ANGLE CLASSES OF MALOCCLUSION
BY SEX AND SOCIOECONOMIC LEVEL

	Total Sample		Sex				Socioeconomic Level					
			Male		Female		High		Medium		Low	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Class I acceptable occlusion	63	14.2	22	10.8	41	17.1	7	12.7	44	14.1	12	16.0
Class I malocclusion	160	36.0	81	39.7	79	32.9	18	32.8	112	35.6	30	40.0
Class II Division 1 malocclusion	180	40.4	86	42.1	94	39.2	22	40.0	130	40.7	28	37.4
Class II Division 2 malocclusion	18	4.2	5	2.5	13	5.4	2	3.6	14	5.2	2	2.6
Class III malocclusion	15	3.8	7	3.4	8	3.3	1	1.8	12	3.8	2	2.7
Non classifiable malocclusion	8	1.4	3	1.5	5	2.1	5	9.1	2	.6	2	1.3
Total	444	100.0	204	100.0	240	100.0	55	100.0	314	100.0	75	100.0
			$X^2 = .78$				$X^2 = 2.35$					

TABLE XII

MEANS AND STANDARD ERRORS FOR EACH OF SEVEN CONTINUOUS OCCLUSAL VARIABLES BY SEX, OCCLUSION AND SOCIOECONOMIC LEVEL

	Total Sample		Sex				Occlusion				Socioeconomic Level					
			Male		Female		Acceptable		Malocclusion		High		Medium		Low	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Overjet (MM)	+3.71	.10	+3.87	.14	+3.57	.13	+2.45	.26	+3.91	.10	+4.08	.28	+3.13	.11	+3.36	.23
Overbite (MM)	+3.88	.09	+4.05	.13	+3.74	.12	+2.95	.24	+4.03	.10	+3.76	.27	+3.94	.11	+3.73	.22
Labiolingual spread (MM)	2.25	.08	2.43	.12	2.10	.11	.33	.21	2.57	.09	2.06	.24	2.24	.09	2.45	.19
Small rotation number of teeth or displacement	1.77	.05	1.79	.08	1.75	.07	.69	.14	1.94	.06	1.62	.15	1.78	.06	1.82	.13
Large rotation number of teeth or displacement	1.42	.06	1.41	.09	1.43	.08	.10	.16	1.64	.06	1.26	.17	1.41	.07	1.55	.14
Handicapping labio lingual deviation index score	10.21	.20	10.57	.30	9.90	.28	5.95	.55	10.89	.22	9.84	.60	10.37	.24	9.78	.49
Treatment priority index score	6.39	.19	6.55	.29	6.25	.26	1.26	.51	7.24	.21	6.29	.59	6.49	.23	6.00	.47

effects for the continuous occlusal variables are summarized in Table XIII. Of the ninety-two possible second and third order interactions, only three showed statistical significance and were therefore disregarded.

The results of these continuous occlusal variables indicate a trend in which boys have a more severe malocclusion than girls. The overjet, overbite, labio-lingual spread and Handicapping Labio-lingual Deviation Index score are all significantly greater for boys as compared to girls. As expected each of the occlusal variables showed a statistically significant difference when the acceptable occlusion group was compared to the malocclusion group. On the basis of socioeconomic level only two variables were statistically different, labio-lingual spread and small rotation or displacements and these were only significant at the 5% level of confidence. The distribution of children according to the Handicapping Labio-lingual Deviation Index and the Treatment Priority Index is presented in Tables XIV and XV, respectively. According to the Handicapping Labio-lingual Deviation Index (Draker, 1958) approximately 65% of the children had an orthodontic condition of a non-handicapping nature, while 12% of the children were classified as having a handicapping malocclusion. The remaining 23% of the children were grouped in the so called "grey area" where treatment is desirable but not mandatory.

The Treatment Priority Index (Grainger, 1966) classified 33.8% of the children as having minor manifestations of malocclusion with treat-

TABLE XII

SIGNIFICANT EFFECTS REVEALED BY ANALYSIS OF VARIANCE FOR CONTINUOUS OCCLUSAL VARIABLES

	Sex	Occlusion	Socioeconomic Level
Overjet	**	***	
Overbite	**	***	
Labio-Lingual Spread	**	***	*
Small rotation or displacement		***	*
Large rotation or displacement		***	
Handicapping Labio-Lingual deviations	**	***	
Treatment priority index score		***	

* Significant at the 5% level.
** Significant at the 1% level.
*** Significant at the .1% level.

TABLE XIV

DISTRIBUTION OF CHILDREN ACCORDING TO THE HANDICAPPING LABIO-LINGUAL DEVIATION INDEX

Index Score	Number	Per Cent	Interpretation
0-11	279	64.9	Orthodontic condition of non-handicapping nature
12-14	100	23.4	Grey area - treatment desirable
15+	55	11.7	Handicapping malocclusion

TABLE XV

DISTRIBUTION OF CHILDREN ACCORDING TO THE TREATMENT PRIORITY INDEX

Index Score	Number	Per Cent	Interpretation
0-3	145	33.8	Minor manifestations of malocclusion treatment needs slight
4-6	107	25.0	Definite malocclusion treatment desirable
7-9	88	20.6	Severe handicap, treatment highly desirable
10+	87	20.6	Very severe handicap treatment mandatory

ment needs slight, and 20.6% of the children as having a very severe handicapping malocclusion with treatment mandatory. Of those remaining, 25% were classified as having a definite malocclusion with treatment desirable and 20% as having a severe handicap with treatment highly desirable.

A comparison of between the Handicapping Labio-lingual Deviation Index and Treatment Priority Index will be presented in the discussion.

Discrete Occlusal Variables

Table XVI shows the number and per cent of children manifesting anterior crossbites or missing lateral incisors (0_6, 0_7, 0_8 and 0_9) and the significant differences revealed by the contingency chi square test. These variables are presented for the total sample, for each sex and each of the three socioeconomic levels. No child in the sample was found to have a cleft lip or palate, or a severe traumatic deviation, therefore these variables do not appear in Table XVI.

As expected, the results show that no children in the acceptable occlusion group exhibited an anterior crossbite while 5.4% of the total sample was so classified. In addition, no child in the high socio-economic group exhibited an anterior crossbite while 6.0% of the medium and 6.6% of the low socioeconomic group did.

The distribution of anterior crossbite for the three main levels studied is shown in Table XVII. It can be seen that although there are more children in the lower socioeconomic group with anterior crossbite,

TABLE XVI

NUMBER AND PER CENT DISTRIBUTION OF DISCRETE OCCLUSAL VARIABLES BY SEX, OCCLUSION AND SOCIOECONOMIC LEVEL

	Anterior Cross Bite			Missing Lateral Incisors		
	Number	Per Cent	X^2	Number	Per Cent	X^2
Total sample (N=444)	24	5.40	--	12	2.70	--
Males (N=204)	10	4.90	.14	5	2.50	.08
Females (N=240)	14	5.80		7	2.90	
Acceptable occlusion (N=63)	0	0.00	4.36*	0	0.00	2.06
Malocclusion (N=381)	24	6.29		12	3.20	
High socioeconomic group (N=55)	0	0.00		2	3.60	
Medium socioeconomic group (N=314)	19	6.05	13.07***	10	3.18	2.65
Low socioeconomic group (N=75)	5	6.66		0	0.00	

* Significant at the 5% level.
*** Significant at the .1% level.

TABLE XVII

NUMBER AND PER CENT DISTRIBUTION OF CHILDREN WITH ANTERIOR CROSSBITE BY SEX, OCCLUSION AND SOCIOECONOMIC LEVEL

	No Anterior Crossbite		Anterior Crossbite One Tooth		Anterior Crossbite Two Teeth		Anterior Crossbite Three Teeth		Anterior Crossbite Four or More Teeth	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Total sample	483	94.4	17	4.0	5	1.2	1	.20	1	.20
Male	183	94.8	6	3.1	4	2.1	0	.00	0	.00
Female	219	94.0	11	4.8	1	.4	1	.40	1	.40
Acceptable occlusion	631	100.0	--	---	-	---	-	---	-	---
Malocclusion	343	93.5	17	4.6	5	1.5	1	.27	1	.27
High socioeconomic level	55	100.0	--	---	-	---	-	---	-	---
Medium socioeconomic level	290	93.8	12	3.9	5	1.6	1	.30	1	.30
Low socioeconomic level	70	93.1	5	6.9	-	---	-	---	-	---

no child in this group was found to have more than one anterior tooth in crossbite.

As indicated in Table XVII only 2.7% of the children examined exhibited congenitally missing lateral incisors with no significant differences found between the sexes or socioeconomic levels.

Photographic Variables

The fourteen facial measurements obtained from the photographic analysis were used to formulate a photographic index. The standard, or dependent variable, to which each of the photographic variables was correlated was the sum of the individual scores which four orthodontists assigned each child. This sum was referred to as the total photo score and ranged from 0 for a child regarded as having good facial esthetics, to 4 for a child demonstrating a dental or skeletal dysplasia. Figure 5 (presented in Materials and Methods) was an example of children having total photo scores of 0-1, 2-3 and 4, representing good, average and poor facial esthetics.

A regression analysis of the fourteen facial measurements on the total photo score indicated that only four of the independent variables bore a significant relation to the dependent variable. These were used as independent variables in a second multiple regression analysis. The four variables retained (Figure 6) were P_2 (facial angle), P_5 (angle ANPg), P_{12} (Naso-labial angle), and P_{14} (lip posture). These were found to have a multiple correlation coefficient with the total photo score

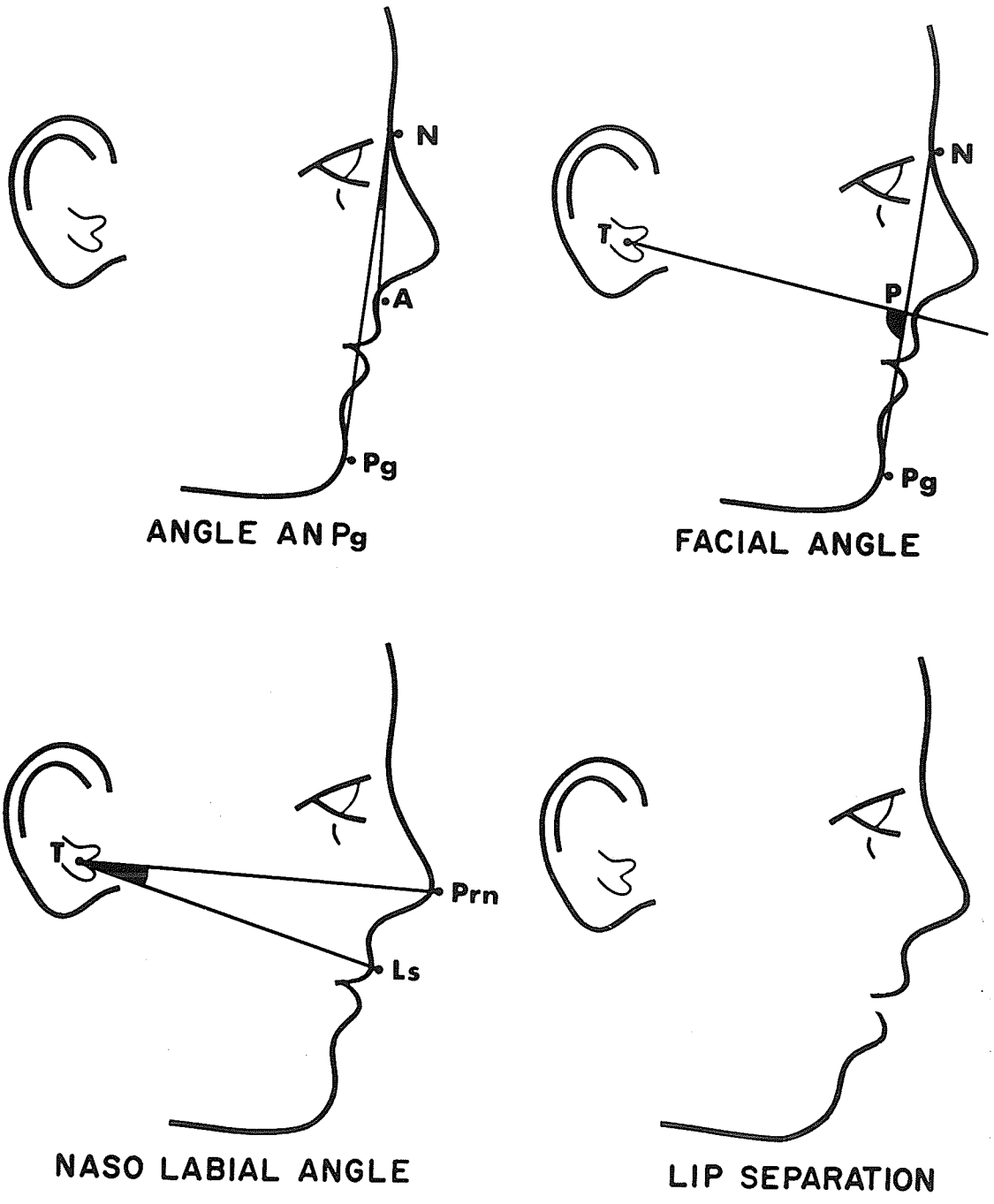


Figure 6. Diagramatic illustration of the four variables comprising the Photo Index.

of .55*. The results of the second multiple regression analysis are shown in Table XVIII. The photographic index could therefore be calculated for any given subject by the following formula:

$$\text{Photo Index (PI)} = 7.6-.07P_2+.14P_5-.06P_{12}+1.5P_{14}$$

Simple Correlations

The Pearson product moment correlation coefficients between all possible pairs of 23 selected variables are presented in the Appendix (Table XXXXIII). Since correlations of the variables studied with each of the Treatment Priority Index, Handicapping Labio-lingual Deviation index and total photo score merit special consideration they are presented in Table XIX.

From this table it may be noted that although most of the coefficients are significant, the overjet, overbite, small rotation, large rotation and labio-lingual spread bear the strongest interrelationship with the final index scores. Of the facial measurements the AB to facial plane and ANB angles have the highest correlation coefficient with the indices considered; while the ANP_g and maxillary facial angles correlate well (.33) with the total photo score only.

The interrelationships among the three index scores may be seen in Table XIX. The correlation coefficient between the Treatment Priority

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* Significant at the 1% level.

TABLE XVIII

RESULTS OF MULTIPLE REGRESSION ANALYSIS

Variable		Slope	Standard Error of Slope
P_2	Facial angle	-.07**	.02
P_5	Angle ANPg	+.14**	.05
P_{12}	Nasolabial angle	-.06*	.03
P_{14}	Lip posture	+1.50**	.26

Intercept = 7.6

Multiple correlation coefficient = .55**

* Significant at the 5% level.
** Significant at the 1% level.

TABLE XIX

SIMPLE CORRELATION COEFFICIENTS BETWEEN SELECTED PAIRS OF VARIABLES

	Handicapping Labio-Lingual Deviation Index	Treatment Priority Index	Total Photo Score
Overjet	.54	.40	.32
Overbite	.64	.37	.14
Small rotations	.30	.35	.14
Large rotations	.43	.58	.22
Labio-lingual spread	.50	.45	.21
Anterior crossbite	.08	.03	.01
Missing permanent teeth	-.12	-.13	-.14
Facial angle	-.11	-.10	-.19
AB to facial plane	.25	.13	.13
ANB	.18	.14	.29
ANPg	.10	.08	.33
Lower lip-chin-facial plane	.07	.07	.32
Lower lip-upper-facial lip plane	.17	.07	.18
Nose angle	-.01	-.02	-.11
Orientation angle	-.07	-.11	-.26
Maxillary facial angle	.13	.06	.33
Upper lip-nose-facial angle	-.05	-.06	-.09
Nasal angle	-.04	-.08	-.12
Maxillary angle	-.06	.04	-.05
Mandibular angle	.03	.08	.17
Handicapping labio-lingual deviation index	---	.57	.38
Treatment priority index	.57	---	.33
Total photo score	.38	.33	---

Index was .57 while the correlation between the total photo scores with these indices was somewhat lower (.38 and .33 for the Treatment Priority and Handicapping Labio-lingual Deviation indices, respectively).

DISCUSSION

CHAPTER V

DISCUSSION

Since it is likely that publicly funded dental care programs will become a reality in the future, it is necessary to determine the dental requirements of each sector of the Canadian population. The present study was therefore undertaken to characterize the status of malocclusion in a sample of Winnipeg school children, to determine the treatment needs and demands of these children, and to examine several methods of establishing treatment priority.

The data compiled in this investigation together with the index scores calculated from it, have been classified into the following three groups; dental care variables, occlusal variables, and photographic variables. The variables included in each of these groups have been presented in Tables III, IV and V, respectively.

Dental Care Variables

Investigation of the general dental status of each child has revealed the following trend: The higher the socioeconomic level of the child; the more likely he was to have a family dentist; to have received orthodontic treatment, or at least to have had this treatment suggested; and the less likely to have lost any first permanent molar teeth. Children belonging to the low socioeconomic group received routine dental treatment for no charge at the clinics established by the City of Winnipeg. Otherwise it is unlikely that they would have received

any dental treatment (Konyk, 1971).

Comparison between the high, medium and low socioeconomic groups indicated that, in spite of the free dental treatment available to children in the low socioeconomic group, a significantly greater number of children in this group had lost one or more of their first permanent molars. This may have occurred because these children neglected to appear for dental treatment until their teeth were decayed beyond repair; or because the dentists in the public clinics could not provide the extensive restorative treatment which may have been required. It is interesting to note that although there were a greater number of girls than boys who had lost one or more of their mandibular first permanent molars, there were no significant differences between the sexes in the number of children who had lost one or more of their maxillary first permanent molars.

As expected the socioeconomic level of the child had a great bearing on whether or not he received orthodontic treatment. In the high socioeconomic group 18.2% of the children received treatment as compared to only 5.4% of the medium and 1.4% of the low socioeconomic groups. According to the Canadian Dental Association Brief of 1962 the percentage of children receiving orthodontic treatment in the Province of Manitoba was .4% and in the Dominion of Canada .7%. These figures may be somewhat misleading because orthodontists are generally only located in large metropolitan areas such as Greater Winnipeg, while the percentage figures were calculated on the basis of the total provincial

population. In the past ten years the number of orthodontists* in Greater Winnipeg has increased from four to eight, while the population has increased by only 50,000** people in this same time period. For these reasons, the Canadian Dental Association Brief (1962) tabled almost ten years ago, is certainly in need of updating.

Of the 381 children who exhibited some form of malocclusion only 7.4% (28) were being treated by certified orthodontists while only one child was being treated by a dentist in general practice. This may indicate some reluctance of dentists to treat orthodontic conditions. In fairness however, it should be emphasized that this survey was conducted only in the City of Winnipeg and it is entirely possible that many recent graduates, practicing in the suburbs, are providing some orthodontic treatment for their patients.

It was noted that more children in the low, than in the medium, or high socioeconomic groups felt that they had "straight teeth". This was probably because orthodontic treatment was not frequently suggested for children in this low group. It was apparent that, because of the financial position of families in the low socioeconomic group, dentists in the public clinics felt that there was little to be gained by suggesting orthodontic treatment for children in this group.

In general most children felt that they had "straight" teeth and

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* Canadian Dental Association Directory (1962, 1971)
** City Clerk, Winnipeg, Manitoba, Personal Communication, 1971.

did not require orthodontic treatment. Since there is little evidence to suggest that, orthodontic therapy is biologically beneficial, it seems that, in the absence of functional or pathological conditions, more emphasis should be placed on the treatment desires of the patient.

Angle Classification

Since Angle introduced his classification of malocclusion in 1899, innumerable studies have attempted to determine the prevalence of each of the three classes of malocclusion. In Table I (Review of Literature) there were 29 studies cited. These were selected because they were predominently concerned with the permanent dentition period of development as was the present study. The disparity of the incidences of the various Angle classes of malocclusion reported in these studies was not unexpected and in fact supports the findings of Massler and Frankel (1951). They attributed these differences to the varying criteria used in assessing normal and abnormal occlusion; to the wide range of age groups studied and reported together; and to the small number of children included in some samples. In addition, with possible differences in the ethnic background of the samples investigated and the subjective nature of Angle's method of classification, it is evident that comparison of results between studies is somewhat futile. In spite of this, there are two investigations which ought to be compared to the present study because they were also concerned with twelve year old Canadian school children. These studies are presented in Table XX. Although

TABLE XX

COMPARISON OF CANADIAN STUDIES WHICH EMPLOYED THE ANGLE CLASSIFICATION OF MALOCCLUSION

Investigator	Popovich	MacKay	Present Study
Location	Burlington, Ontario	Forest Hill, Ontario	Winnipeg, Manitoba
Year	1958	1966	1971
Sample size	199	280	444
Age (years)	12	12	12
Class I occlusion	12% ± 2.76*	15.5% ± 2.84*	14.2% ± 2.91*
Class I malocclusion	54.4% ± 3.53*	12.3% ± 2.96*	36.0% ± 2.27*
Class II malocclusion	31.6% ± 3.30*	63.6% ± 2.87*	44.6% ± 2.36*
Class III malocclusion	2.0% ± 2.83*	8.6% ± 2.07*	3.8% ± 2.30*
Total malocclusion	88% ± 2.30*	85.4% ± 2.11*	85.8% ± 1.66*

* S.E. = $\sqrt{npq}$

there is no statistically significant difference between the total incidence of malocclusion reported in these studies, the authors do not agree on the prevalence of the various Angle classes of malocclusion. Popovich (1958) reported that the incidence of Class I malocclusion was 54.4% while MacKay (1966) reported an incidence of only 12.3%. The percentage found in the present study falls between these with a 36.0% incidence of Class I malocclusion. A similar relationship between these studies was found for Class II and Class III malocclusions. It seems unlikely that these variations were due to differences in sampling and a more plausible explaination is that the point of demarcation between the Angle classes of malocclusion is too vague.

In the present study no sex differences were noted in the prevalence of the various Angle classes of malocclusion. This supports the findings of Krogman (1951), Massler and Frankel (1951) and Rosensweig (1961).

Incisor Relationship

The mean values obtained for overjet and overbite for the total sample and for each of the three main levels studied, were presented in Table XII. A comparison between these results and those reported by other investigators is shown in Tables XXI and XXII. In the present study a significant difference between the sexes and types of occlusion was noted in the degree of overjet and overbite. While it was anticipated that those children with acceptable occlusion would have smaller

TABLE XXI

COMPARISON OF THE DEGREE OF OVERJET REPORTED BY VARIOUS INVESTIGATORS

Investigator	Sample Size	Age (Years)	Overjet (MM)		
			Male	Female	Total Sample
Bjork (1953)	322	12	4.1	----	4.1
Fulton (1965)	977	10-19	3.22	3.14	3.18
Summers (1966)	96	12	----	----	2-3
Present study (1971)	444	12	3.87	3.57	3.71

TABLE XXII

COMPARISON OF THE DEGREE OF OVERBITE REPORTED BY VARIOUS INVESTIGATORS

Investigator	Sample Size	Age (Years)	Overbite (MM)		
			Male	Female	Total Sample
Bjork (1953)	322	12	2.6	----	2.60
Fleming (1961)	74	12	----	----	4.37
Fulton (1965)	977	10-19	3.38	3.10	3.24
Present study (1971)	444	12	4.05	3.14	3.88

overjet and overbite values, the finding that males had significantly greater mean values for overjet and overbite than females was somewhat unexpected.

Previous investigations by Flemming (1961), Fulton (1965) and Summers (1966), demonstrated no significant differences between males and females for overjet and overbite. This disparity between the previous reports and the present investigation may be due to the more random nature of the present sample; to the larger sample size examined in this investigation; and to actual population differences. In addition; the present study considered only the positive alternative in calculating the means for overjet and overbite and did not include openbite or mandibular protrusion.

The incidence of negative overjet (underjet) was found to be 1.14% and the incidence of openbite 2.50%, with mean values of .015 mm and .04 mm, respectively. These figures compare favorably with those reported by Fulton (1965) who found the mean value for underjet to be .01 mm and for openbite .05 mm.

The number and percentage of children with anterior crossbites was presented in Table XVI. The fact that no child in the high socioeconomic level was found to have an anterior crossbite may indicate that the parents of these children regard this condition as extremely disfiguring, and seek treatment early in the deciduous and mixed dentition period of development. If simple anterior crossbites were corrected early there would probably be no evidence of their presence by twelve years of age,

the age level studied.

Intra-arch Crowding

The assessment of intra-arch crowding was made by measuring the number of rotations and displacements using the method introduced by Van Kirk and Pennel (1959), and by calculating the labio-lingual spread (Draker, 1958). The finding of no significant sex differences in the number of small or large rotations or displacements concurs with that of Massler and Frankel (1951) who reported no striking difference between boys and girls in the number of maloccluded teeth.

A most interesting finding was the high correlation between labio-lingual spread and the number of rotated or displaced teeth. This would indicate that the single measurement of labio-lingual spread, introduced by Draker (1958), could be used to estimate the overall number of rotations or displacements. The correlation coefficient (Appendix, Table XXXXIII) between small rotations and displacements, and labio-lingual spread was .45 while that of large rotations and displacements, and labio-lingual spread was .72.

Indices of Malocclusion

Traditionally, the incidence of malocclusion has been reported in terms of the various classes introduced by Angle in 1899. The problem with this method of classification was that it was too subjective and provided little information concerning the severity of the condition or

the urgency for treatment. In order to reduce these shortcomings, and to objectify the assessment of malocclusion, numerous investigators (Draker, 1958; Grainger, 1966; Summers, 1966; Salzmann, 1968) have devised indices to classify occlusion according to the severity of the deviation.

The primary purpose of these indices of malocclusion was to quantitatively express the severity of the malocclusion, to establish treatment priority in an unbiased manner; and if necessary, to aid in the disbursement of insurance and government funds for orthodontic treatment. These indices may also be used to assess the effectiveness of specific preventive and interceptive orthodontic procedures as well as a tool in epidemiological studies.

In selecting the indices to be used in this study, only those which had been used in previous investigations were considered. This was necessary to provide a basis for comparison. The Handicapping Labio-lingual Deviations Index (HLD) developed by Draker (1958) and the Treatment Priority Index (TPI) of Grainger (1966) were selected. The former index was employed by Fulton and Hughes (1965), and Carlos and Ast (1966); the latter has been used by MacKay (1966).

The Handicapping Labio-lingual Deviation Index (HLD) was derived from seven basic measurements of overjet, overbite, mandibular protrusion, openbite and labio-lingual spread. The presence or absence of clefts and severe traumatic deviations was recorded. These measurements, modified by weighting factors, were summed to yield the index

score which ranged between 0 and 15 plus. According to Draker* the HLD scale may be divided into three areas for assessment purposes as illustrated in Table XXIII. A score of 0-11 indicates an orthodontic condition of a non-handicapping nature while a score of 15 and over is indicative of a severe handicapping malocclusion. The "grey area" occurs when an index score falls between 12 and 14. This is the area where treatment is desirable but not mandatory.

TABLE XXIII

INTERPRETATION OF HANDICAPPING LABIO-LINGUAL DEVIATION INDEX SCORES

HLD Index Score	Interpretation
0-11	Orthodontic condition of non-handicapping nature
12-14	"Grey Area" treatment desirable
15+	Handicapping malocclusion

* Personal communication, 1970.

The means and standard errors for the Handicapping Labio-lingual Deviation Index scores and the main components of this index were presented, for the various groups under study (sex, occlusion, socio-economic level), in Table XII, while the significant effects revealed by the analysis of the variance were shown in Table XIII. As expected, there were highly significant* differences in index scores between the acceptable and the malocclusion groups with all values for the acceptable group being lower. The mean index score for those with acceptable occlusion was 5.95 ± .55 and for those with malocclusions 10.89 ± .22. The distribution of children into the three groups suggested by Draker is presented in Table XXIV for the total sample and for each of the sexes.

TABLE XXIV

PER CENT DISTRIBUTION OF CHILDREN ACCORDING TO HANDICAPPING LABIO-LINGUAL DEVIATION INDEX

HLD Index Score	Male (N=204)	Female (N=240)	Total Sample (N=444)
0-11	60.3	66.9	64.9
12-14	23.0	22.6	23.4
15+	16.7	10.5	11.7

* $p < .01$.

The results of the present study indicated that there were significant differences* in the mean Handicapping Labio-lingual Deviation Index scores for males (10.57) as compared to females (9.90). Fulton and Hughes (1965), and Ast, Carlos and Cons (1965), however, reported no significant differences in the Handicapping Labio-lingual Deviation Index scores between males and females in their respective samples.

In the present study, approximately 11.7% of the 444 children examined had a malocclusion severe enough to be termed handicapping**. Using similar criteria for the assessment of handicapping malocclusion, Ast, Carlos and Cons (1965), reported that 14.4% of the 1,413 children they examined had a severe and potentially handicapping malocclusion.

The mean Handicapping Labio-lingual Deviation Index scores reported by various investigators are presented in Table XXV. A comparison of these scores indicated a somewhat greater severity of malocclusion for children examined in the present study. Comparison of the results obtained in the studies presented in Table XXV may not be valid however due to the differences in age ranges examined and reported together, and the different geographic locations in which these studies were carried out. No statistical test of significance between these studies was possible because of the failure of these investigators to report the standard error of the means for the index scores they obtained.

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* $p < .01$.
** HLD index score > 14.

TABLE XXV

COMPARISON OF HANDICAPPING LABIO-LINGUAL DEVIATION (HLD) INDEX SCORES REPORTED BY VARIOUS INVESTIGATORS

Investigator	Sample Size	Age (Years)	Mean HLD Index Score		
			Male	Female	Total
Fulton and Hughes (1965)	977	10-19	8.16	7.78	7.98
Carlos and Ast (1966)	1413	15-18	----	----	9.42
Present study (1971)	444	12	10.57	9.90	10.21

The Treatment Priority Index (TPI) was based on a study of the relationship of eight manifestations of occlusal disorders. The variables observed were the antero-posterior relationship of the first permanent molars, the overjet or underjet, the overbite or openbite, the number of teeth rotated or displaced, posterior crossbite and congenitally missing incisors.

The range of Treatment Priority Index scores and their interpretation was outlined by Grainger (1966) and is presented in Table XXVI. An index score of 0 to 3 indicates a minor malocclusion with treatment needs slight while a score of 4 to 6 demonstrates a malocclusion with treatment desirable. The index range from 7 to 9 is indicative of a severe handicap with treatment very desirable and a score of 10 and over constitutes a very severe handicap with treatment mandatory. The distribution of children into the groups suggested by Grainger (1966) is presented in Table XXVII for the total sample and for each of the sexes.

In contrast to the Handicapping Labio-lingual Deviation Index scores the results of the Treatment Priority Index scores revealed no significant differences between males and females. This supports the findings of MacKay (1966) who also reported no sex differences in Treatment Priority Index scores for a sample of 280 twelve year old children.

In his study, MacKay grouped the sample of children into three, rather than four categories. For purposes of comparison the results

TABLE XXVI

INTERPRETATION OF TREATMENT PRIORITY INDEX SCORES

Index Score	Interpretation
0-3	Minor manifestations of malocclusion treatment needs slight
4-6	Definite malocclusion; treatment desirable
7-9	Severe handicap; treatment highly desirable
10+	Very severe handicap; treatment mandatory

TABLE XXVII

PER CENT DISTRIBUTION OF SAMPLE ACCORDING TO THE TREATMENT PRIORITY (TPI) INDEX

TPI Score	Male (N=204)	Female (N=240)	Total Sample (N=444)
0-3	33.3	32.0	33.8
4-6	30.9	20.4	25.0
7-9	16.1	23.0	20.6
10+	19.7	24.6	20.6

of the present study were similarly grouped and are presented in Table XXVIII.

This table illustrates discrepancies between studies in the percentage of children reported within each of the three categories (mild, moderate and severe) described. Although these discrepancies may have been due to sampling differences, it is more probable that they were due to the different philosophies considered in measuring various components of the index. In the measurement of tooth displacement MacKay states "minor malpositions were ignored". This introduces some degree of subjective assessment into the index and may tend to make the scores either "higher or lower" depending on the view of the investigator conducting the examinations.

TABLE XXVIII

COMPARISON OF TREATMENT PRIORITY INDEX (TPI) SCORES REPORTED BY VARIOUS INVESTIGATORS

Investigator	Sample Size	Age (Years)	Per Cent Distribution of Sample According to TPI Scores*		
			Mild	Moderate	Severe
MacKay (1966)	280	12	49.2	32.2	18.6
Present study (1971)	444	12	33.8	25.0	41.2

* Rating system suggested by MacKay (1966)
Mild 0-3.9; Moderate 4-6.7; Severe 7-10+

In general, it may be noted that the present study revealed both a higher incidence of malocclusion, as seen by the greater number of children included in the handicapping range of index scores, and a more severe form of malocclusion, as seen by the higher mean index scores reported in the present study. These differences may have been due to one or more of the following factors; differences in sampling, differences in geographic locations and ethnic composition of the population, differences in age ranges examined and reported together, and differences in the subjective evaluation of certain components included in the indices employed.

Ideally, an index of malocclusion should quantitatively describe the severity of the condition and numerically rank the children in order that a certain percentage of them, based on the availability of funds, treatment facilities, and treatment personal, may be treated. Since both the Handicapping Labio-lingual Deviation and Treatment Priority Indices are currently in use, it is important to consider the differences in rank assigned children by each of these indices. In other words, is it possible that according to one index a child would require treatment, whereas, according to the other he may not? This was examined by tabulating the results of the two indices studied. This tabulation is presented in the two-way table XXIX. From this two-way table it was found that both indices concurred in 68% of the cases: That is, it was agreed that 221 children had minimal treatment needs, 32 children had severe malocclusion with treatment mandatory, and 39 children were

TABLE XXIX

DISTRIBUTION OF CHILDREN ACCORDING TO TREATMENT PRIORITY INDEX AND HANDICAPPING LABIO-LINGUAL DEVIATION INDEX

HANDICAPPING LABIO-LINGUAL DEVIATION INDEX	TREATMENT PRIORITY INDEX		
	0-6	7-9	10+
0-11	221	32	22
12-14	24	39	34
15+	6	17	32

COMPLETE AGREEMENT BETWEEN INDICIES

MODERATE AGREEMENT BETWEEN INDICIES

COMPLETE DISAGREEMENT BETWEEN INDICIES

classified as being in the undecided, "grey area" where treatment was desirable but not mandatory. Moderate agreement occurred where one index placed a child in the undecided category while the other index classified him as either definitely needing or not needing treatment. This occurred in 23.3% of the cases. Complete disagreement between the indices arose in the 7.7% (6 children) of the cases which the Handicapping Labio-lingual Deviation Index classified as having handicapping malocclusions while the Treatment Priority Index classified them as requiring minimal treatment. A similar situation occurred when the Treatment Priority Index classified 22 children as having a handicapping malocclusion while the Handicapping Labio-lingual Deviation Index classified them as requiring minimal treatment. It was also noted (Table XXIX), that 23.5% (122) of the children had a moderate or high score on both indices indicating that they would benefit from orthodontic treatment.

The coefficient of correlation between the TPI and HLD indices did not exceed .57, a relatively low correlation, demonstrating that these two indices were not measuring the same aspects of malocclusion. In addition neither of these indices contained measurements for the evaluation of facial harmony and balance. This suggested that there was a need for another index of malocclusion based perhaps on a combination of the factors included in the Treatment Priority and Handicapping Labio-lingual Deviation Indices and including an evaluation of facial form and balance.

Photographic Variables

In developing a quantitative method of assessing facial form and balance it was evident that it would not be practically possible for epidemiological field studies to employ the cephalometric radiographic method of assessing skeleto-dental relationships. A photographic index was therefore developed to aid in the evaluation of handicapping malocclusion and treatment priorities. This index is intended to be used in conjunction with an index of malocclusion in epidemiological field studies and is not meant to replace a more detailed diagnostic and cephalometric radiographic evaluation. The photographic analysis was designed to quantitatively assess some characteristics of facial harmony and to evaluate the contribution of the various photographic variables to facial harmony.

The dependent variable, or index score, was developed by combining the individual scores which four orthodontists assigned each of the 290 photographs they examined. The interpretation of these index scores is presented in Table XXX. The independent variables were the the fourteen facial measurements made on each photograph.

A multiple regression analysis was performed to determine the effect of each of the independent variables on the photographic score. The objective of this was to develop an index the value of which may be calculated from a combination of the fourteen facial measurements studied. It was found that, of the fourteen facial measurements analyzed, t e n did not bear a significant relation to the dependent variable

TABLE XXX

INTERPRETATATION OF PHOTOGRAPHIC INDEX SCORES

Index Score	Interpretation
0-1	Good facial esthetics
2	Average facial esthetics
3-4	Poor facial esthetics

and were disregarded. The four variables remaining, as illustrated in Figure 6, Chapter II, were the facial angle (T-P-Pg); the Angle formed by A point, nasion, and pogonion (Angle ANPg); the naso-labial angle (PrN-T-LS); and the lip separation. The first three of these variables were measured in degrees; the fourth, the lip separation, was recorded as being either open or closed lip posture. It was found that the Photographic Index could be calculated for any given subject by the following formula:

$$\text{Photographic Index} = 7.6 - .07P_2 + .14P_5 - .06P_{12} + 1.5P_{14}$$

where P_2, P_5 and P_{12} represent the facial angle, the ANPg angle and the naso-labial angle, respectively. These angles were all measured in degrees. Variable P_{14} represented lip posture which was recorded as being either open or closed*.

* Open lip posture score 1.
Closed lip posture score 0.

This formula indicates that an increase in either the facial angle (P_2) or the naso-labial angle (P_{12}) by approximately 15 degrees will result in a unit decrease in the index score, thus indicating a pleasing harmonious face. Conversely, the ANPg angle (P_5) affects the total score in the opposite manner with an increase of approximately 7 degrees causing a unit increase in the total photo score which would indicate poor facial esthetics. Lip posture (P_{14}) affects the total photo score to a considerable degree with an open lip posture resulting in a 1.5 unit increase in score indicative of poor facial balance.

Since a higher photographic score reflected a greater degree of skeleto-dental dysplasia in the photograph, children with low ANP_g angles, high facial angles, high naso-labial angles and closed lip posture would be considered to have the most pleasing and most harmonious faces. This combination of facial features is suggestive of a straight profile with adequate upper lip length, a fairly well developed lower facial region and competent lip musculature.

The predictability of the Photographic Index, that is how close a predicted index score would come to that assigned by the four examining orthodontists, was estimated by squaring the multiple correlation coefficient which in this case was .55. This revealed that the predictability was no greater than 30%. This meant that 30% of the total variability in the observed total photographic scores was due to the four variables considered, namely, the facial angle, the ANPg angle, the naso-labial angle and the lip posture. The remainder of the variability

included factors which were either not measured or not able to be measured.

The correlation coefficients were examined for the Treatment Priority, Handicapping Labio-lingual Deviation and Photographic indices and were as follows:

Treatment Priority Index and Handicapping Labio-lingual Deviation Index .... .57

Treatment Priority Index and Photographic Index Score .... .33

Handicapping Labio-lingual Deviation Index and Photographic Index Score .... .38

The fact that the coefficient of correlation between the two indices of malocclusion and the photographic score did not exceed .38 suggested that the Photo Index was measuring factors not included in either of the two indices of malocclusion. This provided further evidence of the need to incorporate an evaluation of facial balance and harmony into an index of malocclusion. An example of the use of the Photographic Index in conjunction with an index of malocclusion is illustrated in Tables XXXI and XXXII.

Table XXXI compares the Handicapping Labio-lingual Deviation Index scores and the Photographic Index scores. It was noted that although 43 children were classified by the handicapping index as having a handicapping malocclusion*, only 23 of these children were also assessed as

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* HLD index score 15+.

TABLE XXXI

DISTRIBUTION OF CHILDREN ACCORDING TO HANDICAPPING LABIO-LINGUAL DEVIATION INDEX AND PHOTOGRAPHIC INDEX

Handicapping Labio-lingual Deviation Index Score	Photographic Index Score		
	0-1	2	3-4
0-11	87	47	48
12-14	13	14	37
15+	7	14	23

TABLE XXXII

DISTRIBUTION OF CHILDREN ACCORDING TO TREATMENT PRIORITY INDEX AND PHOTOGRAPHIC INDEX

Treatment Priority Index Score	Photographic Index Score		
	0-1	2	3-4
0-3	59	18	25
4-6	24	22	18
7-9	16	19	28
10+	10	16	35

having an esthetically poor face by the photographic index. It is these 23 children therefore who should probably be treated first in the group exhibiting handicapping malocclusions.

A similar situation can be illustrated for the Treatment Priority Index (Table XXXII) which classified 61 children as having a handicapping malocclusion* while the Photographic Index classified 35 of these children as having an esthetically poor face. In this case it is these 35 children who should receive the highest priority for treatment.

Another aspect of the Photographic Index is that it could be used to select those children, who for various reasons have low malocclusion index scores, but would greatly benefit from treatment. A good example of this would be a bimaxillary protrusion in which no local occlusal disharmony exists but where facial esthetics are poor.

In epidemiological field investigations it should not be necessary to employ both the Handicapping Labio-lingual Deviation Index and the Treatment Priority Index. It was therefore desirable to determine which of these indices should be used in combination with the Photo Index. To determine this it was necessary to investigate the ability of each index to discriminate between the acceptable and malocclusion groups of children. The per cent frequency distribution of children according to each index was plotted for each of these groups. This is shown in Figure 7. It may be noted that the Treatment Priority Index was the

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* TPI score 10+.

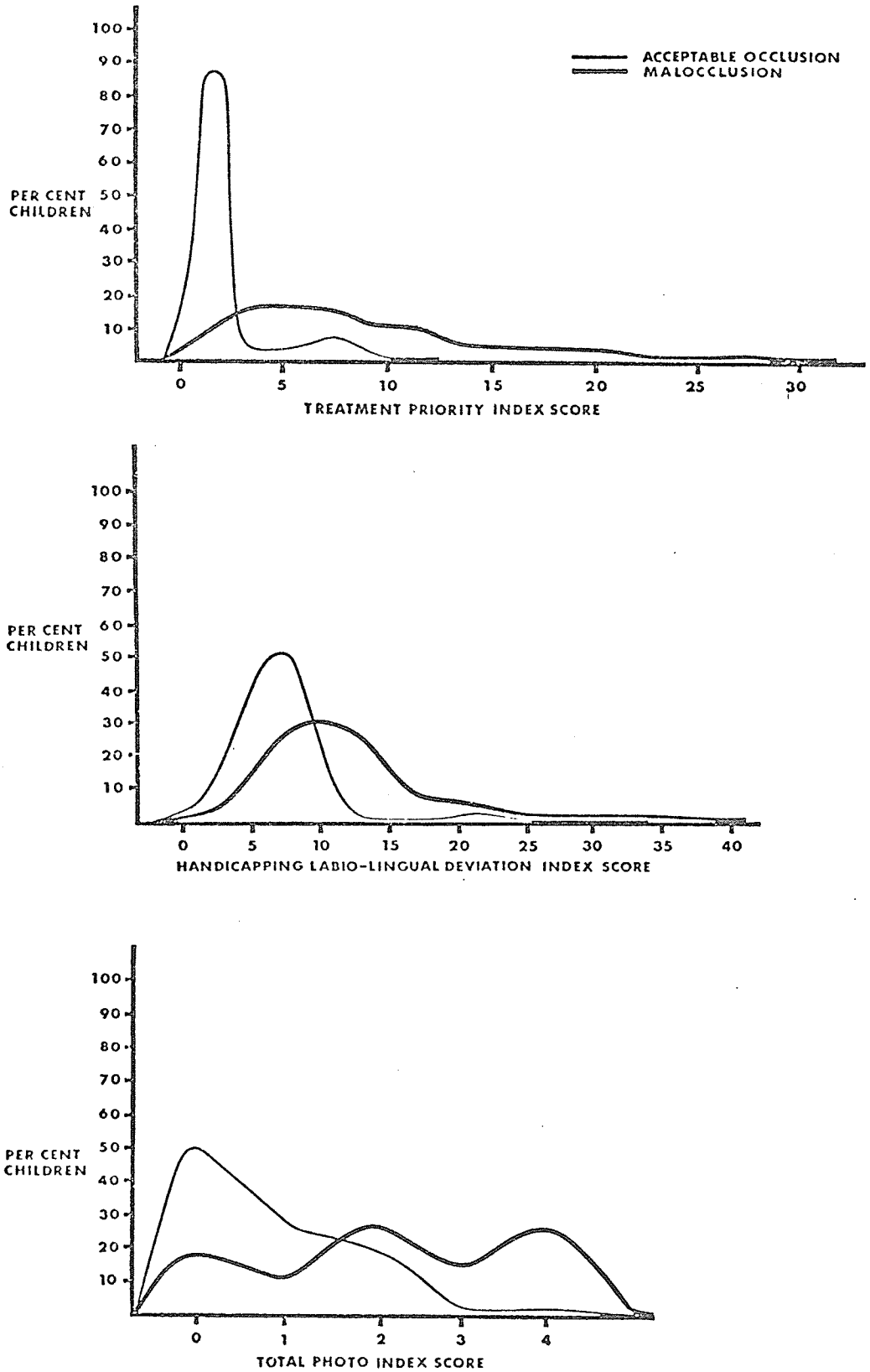

Figure 7. Per cent distribution of the acceptable occlusion and malocclusion groups of children according to the three indices studied.

most discriminatory index followed by the Handicapping Labio-lingual Deviation Index and the Photo Index. Since the Photo Index was designed to evaluate facial harmony and not occlusion, these results suggest that the combined use of the Treatment Priority Index and the Photo Index is best for field work.

SUMMARY AND CONCLUSIONS

CHAPTER VI

SUMMARY AND CONCLUSIONS

The present study was undertaken to characterize the status of malocclusion in a sample of Winnipeg school children; to determine the treatment needs of this population; and to examine several methods of establishing treatment priorities.

A random sample of 444 twelve year old Winnipeg school children was selected. Each child included in the study had a full permanent dentition (excluding third molars). The entire sample was studied as a group and then subgrouped on the basis of their sex, occlusion and socioeconomic level. The occlusion of each child was assessed according to Angle's classification of malocclusion and also according to the indices of malocclusion used in this study; namely, the Handicapping Labio-Lingual Deviation Index and the Treatment Priority Index. A lateral, black and white photograph was taken and analyzed for each of 290 children and a photographic index was developed.

The data gathered in this investigation demonstrated that approximately 85% of the children surveyed exhibited some form of malocclusion at 12 years of age. The indices of malocclusion indicated that 23.5% of the children examined had a moderate to severe form of malocclusion which required orthodontic treatment.

It was found that only 7.4% of the total number of children with malocclusion were receiving treatment. This suggests that there is an

acute orthodontic treatment need in the population studied.

In spite of the fact that there were no significant differences in the incidence or severity of malocclusion in the high, medium and low socioeconomic groups, it was found that 20.8% of the private school children with malocclusion had received treatment as compared to only 6.3% of the public school children and 1.3% of the children attending the dental welfare clinics. This indicated that financial considerations, and not severity of malocclusion, were paramount in determining whether or not a child received orthodontic treatment.

On the basis of the results of this study the following conclusions were drawn.

1. Approximately 85% of the children examined had some form of malocclusion.

2. No child was found to have a perfectly ideal occlusion as some slight dental deviation was present in every child.

3. The indices of malocclusion, suggested that approximately 23% of the total sample of children had a severe malocclusion.

4. The results of the two indices were not strictly comparable because each of them seemed to measure different aspects of malocclusion.

5. No relationship was found between socioeconomic level and the incidence or severity of malocclusion.

6. A definite relationship was found between the socioeconomic level and orthodontic treatment. The higher the socioeconomic level, the more likely the child was to have either received orthodontic treatment or at least have had it suggested.

7. In all but one case the children receiving orthodontic treatment were being treated by certified orthodontists and not by dentists in general practice.

8. A photographic index was developed which, when used in conjunction with an index of malocclusion may aid in the assessment of orthodontic treatment priorities.

9. The predictibility of the photographic index developed should be improved through further investigation in this field.

10. There is an acute orthodontic treatment need in the population studied.

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APPENDIX

TABLE XXXIII

NUMBER AND PER CENT OF CHILDREN
EXAMINED IN EACH LOCATION

Location Surveyed	Number Examined	Per Cent Examined
Isacc Brock	19	4.28
Robertson	23	5.18
John M. King	16	3.60
Champlain	15	3.38
Sir John Franklin	18	4.05
Principal Sparling	25	5.63
Ralph Brown	22	4.95
Victoria Albert	14	3.15
Norquay	19	4.28
Cecil R. Rodes	23	5.18
Somerset	14	3.15
Montrose	19	4.28
Laura Secord	14	3.15
Carpathia	15	3.38
George V	19	4.28
Lord Selkirk	19	4.28
Queenston	20	4.50
Balmoral Hall (*)	13	2.95
St. John Ravencourt (*)	21	4.73
Talmud Torah (*)	21	4.73
Public Clinic (**)	75	16.89
Total	444	100

(*) Private School

(**) Children receiving dental treatment at public dental clinics.

TABLE XXIV

NUMBER AND PER CENT DISTRIBUTION OF CHILDREN ACCORDING TO THE ANGLE CLASSIFICATION OF MALOCCLUSION

	Total Sample		Sex				Socioeconomic Level					
			Male (N=204)		Female (N=240)		High (N=55)		Medium (N=314)		Low (N=75)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total Class I occlusion	63	14.20	22	10.80	41	17.10	7	12.70	44	14.10	12	16.00
Total Class I malocclusion	160	36.00	81	39.70	79	32.90	18	32.80	112	35.60	30	40.00
Total Class II malocclusion	198	44.60	91	44.60	107	44.60	24	43.60	144	45.90	30	40.00
Division 1	124	27.90	58	28.40	66	27.50	13	23.60	95	30.30	16	21.30
Division 1 subdivision right	25	5.60	10	4.90	15	6.30	4	7.30	14	4.50	7	9.30
Division 1 subdivision left	31	6.90	18	8.80	13	5.40	5	9.10	21	6.70	5	6.70
Division 2	13	2.90	4	2.00	9	3.80	2	3.60	10	3.90	1	1.30
Division 2 subdivision right	4	.90	0	.00	4	1.60	0	.00	3	1.00	1	1.30
Division 2 subdivision left	1	.23	1	.50	0	.00	0	.00	1	.32	0	.00
Total Class III malocclusion	15	3.80	7	3.40	8	3.30	1	1.80	12	3.80	2	2.70
Class III malocclusion	6	1.40	2	1.00	4	1.60	1	1.80	5	1.60	0	.00
Subdivision right	2	.45	0	.00	2	.80	0	.00	2	.64	0	.00
Subdivision left	7	1.60	5	2.50	2	.80	0	.00	5	1.60	2	2.70
Non-classifiable malocclusion	8	1.40	3	1.50	5	2.10	5	9.10	2	.60	1	1.30

TABLE XXXV

MEANS AND STANDARD ERRORS FOR 23 CONTINUOUS VARIABLES BY SEX

	Total Sample		Male		Female	
	Mean	S.E.				
Age (Months)	143.40	.28	145.60	.41	142.90	.38
Overjet (MM)	3.71	.10	3.87	.14	3.57	.13
Overbite (MM)	3.88	.09	4.05	.13	3.74	.12
Small Rotations (Number of Teeth)	1.77	.05	1.79	.08	1.75	.07
Large Rotations (Number of Teeth)	1.42	.06	1.41	.09	1.43	.08
Labio-lingual Spread (MM)	2.25	.08	2.43	.12	2.10	.11
Facial Angle (Degrees)	78.78	.21	78.45	.30	79.08	.28
AB to Facial Plane (Degrees)	15.08	.21	15.07	.30	15.09	.29
ANB (Degrees)	8.76	.13	8.86	.19	8.67	.18
ANP (Degrees)	7.80	.15	7.92	.22	7.70	.21
Lower Lip-Chin-Facial Plane (Degrees)	16.87	.39	17.96	.57	15.87	.54
Lower Lip-Upper Lip-Facial Plane (Degrees)	13.20	.32	13.19	.47	13.21	.45
Nose Angle (Degrees)	132.32	.27	133.32	.39	131.41	.37
Orientation Angle (Degrees)	93.35	.23	93.01	.34	93.65	.32
Maxillary Facial Angle (Degrees)	8.66	.15	8.99	.22	8.38	.21
Upper Lip-Nose-Facial Plane (Degrees)	110.60	.37	108.90	.54	112.00	.50
Nasal Angle (Degrees)	21.02	.13	20.93	.19	21.10	.18
Maxillary Angle (Degrees)	12.94	.08	13.09	.12	12.82	.12
Mandibular Angle (Degrees)	18.44	.13	18.50	.19	18.38	.18
Handicapping Labio-lingual Deviation Index	10.21	.20	10.57	.30	9.90	.28
Treatment Priority Index Score	6.39	.19	6.55	.29	6.25	.26
Total Photo Score	1.96	.08	2.07	.12	1.85	.11

TABLE XXXVI

MEANS AND STANDARD ERRORS FOR 23 CONTINUOUS VARIABLES BY OCCLUSION

	Total Sample		Acceptable Occlusion		Malocclusion	
	Mean	S.E.				
Age (Months)	143.40	.28	144.70	.75	143.20	.30
Overjet (MM)	3.71	.10	2.45	.26	3.91	.10
Overbite (MM)	3.88	.09	2.95	.24	4.03	.10
Small Rotations (Number of Teeth)	1.77	.05	.69	.14	1.94	.06
Large Rotations (Number of Teeth)	1.42	.06	.10	.16	1.64	.06
Labio-lingual Spread (Degrees)	2.25	.08	.33	.21	2.57	.09
Facial Angle (Degrees	78.78	.21	79.26	.48	78.67	.23
AB to Facial Plane (Degrees)	15.08	.21	14.37	.49	15.25	.23
ANB (Degrees)	8.76	.13	8.15	.30	8.90	.14
ANP (Degrees	7.80	.15	7.28	.35	7.92	.17
Lower Lip-Chin-Facial Plane (Degrees)	16.87	.39	16.43	.81	16.97	.44
Lower Lip-Upper Lip-Facial Plane (Degrees)	13.20	.32	12.61	.74	13.34	.36
Facial Height	.43	.00	.44	.00	.43	.00
Nose Angle (Degrees)	132.32	.27	132.83	.62	132.20	.30
Orientation Angle (Degrees)	93.35	.23	94.35	.54	93.12	.26
Maxillary Facial Angle (Degrees)	8.66	.15	8.39	.35	8.72	.17
Upper Lip-Nose-Facial Plane (Degrees)	110.60	.37	110.60	.85	110.60	.41
Nasal Angle (Degrees)	21.02	.13	21.70	.30	20.86	.14
Maxillary Angle (Degrees)	12.94	.08	12.89	.20	12.96	.09
Mandibular Angle (Degrees)	18.44	.13	18.24	.30	18.49	.15
Handicapping Labio-lingual Deviation Index	10.21	.20	5.95	.55	10.89	.22
Treatment Priority Index Score	6.39	.19	1.26	.51	7.24	.21
Total Photo Score	1.96	.08	.74	.18	2.25	.09

TABLE XXXVII

MEANS AND STANDARD ERRORS FOR 23 CONTINUOUS VARIABLES BY SOCIOECONOMIC LEVEL

	Total Sample		Socioeconomic Level					
			High		Medium		Low	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Age (months)	143.40	.28	143.20	.33	142.40	.80	145.10	.68
Overjet (MM)	3.71	.10	3.13	.11	4.08	.28	3.36	.23
Overbite (MM)	3.88	.09	3.94	.11	3.76	.27	3.73	.22
Small rotations (number of teeth)	1.77	.05	1.78	.06	1.62	.15	1.82	.13
Large rotations (number of teeth)	1.42	.06	1.41	.07	1.26	.17	1.55	.14
Labio-lingual spread (MM)	2.25	.08	2.24	.09	2.06	.24	2.45	.19
Facial angle (degrees)	78.78	.21	78.81	.25	79.47	.62	78.26	.48
AB to facial plane (degrees)	15.08	.21	15.24	.25	14.72	.63	14.68	.49
ANB (degrees)	8.76	.13	8.90	.15	8.31	.39	8.47	.30
ANP (degrees)	7.80	.15	8.02	.18	7.16	.46	7.36	.36
Lower lip-chin-facial plane (degrees)	16.87	.39	16.88	.47	16.63	1.18	16.96	.92
Lower lip-upper lip-facial plane (degrees)	13.20	.32	13.49	.38	12.09	.96	12.74	.77
Facial height	.43	.00	.43	.00	.44	.00	.43	.00
Nose angle (degrees)	132.32	.27	132.07	.32	132.91	.81	132.91	.63
Orientation angle (degrees)	93.35	.23	93.54	.28	93.47	.70	92.57	.54
Maxillary facial angle (degrees)	8.66	.15	8.82	.18	8.37	.45	8.24	.35
Upper lip-nose-facial plane (degrees)	110.60	.37	110.20	.44	111.70	1.10	111.50	.85
Nasal angle (degrees)	21.02	.13	21.00	.15	20.94	.38	21.13	.30
Maxillary angle (degrees)	12.94	.08	13.40	.10	12.42	.26	12.89	.20
Mandibular angle (degrees)	18.44	.13	18.53	.16	17.62	.38	18.59	.30
Handicapping labio-lingual deviation index	10.21	.20	10.37	.24	9.84	.60	9.78	.49
Treatment priority index score	6.39	.19	6.49	.23	6.29	.59	6.00	.47
Total photo score	1.96	.08	1.97	.09	1.75	.24	2.02	.19

TABLE XXXVIII

SIGNIFICANT EFFECTS REVEALED BY THE ANALYSIS OF VARIANCE FOR CONTINUOUS VARIABLES

	Sex	Occlusion	Socioeconomic Level	Sex x Occlusion	Sex x Socioeconomic Level	Occlusion x Socioeconomic Level	Sex x Occlusion x Socioeconomic Level
Age (months)							
Overjet	**	***			*		
Overbite	**	***					
Small rotations		***	*				
Large rotations		***					
Labio-lingual spread	**	***	*				
Facial angle							
AB to facial plane		*					
ANB		**	*				
ANP			*				
Lower lip-chin-facial plane	**		*				
Lower lip-upper lip-facial plane		*	**				
Facial height		**					
Nose						*	
Orientation angle							
Maxillary facial angle	**						
Upper lip-nose-facial plane	**		**				
Nasal angle		**					
Maxillary angle				**			
Mandibular angle							
Handicapping labio-lingual deviation index	**	***					
Treatment priority index score		***					
Total photo score	*	***					

* Significant at the 5% level.
** Significant at the 1% level.
*** Significant at the .1% level.

TABLE XXXIX

NUMBER AND PER CENT DISTRIBUTION OF SAMPLE ACCORDING TO EACH OF THE DISCRETE VARIABLES BY SEX

	Total Sample (N=444)		Male (N=204)		Female (N=240)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Acceptable occlusion	63	14.19	22	10.80	41	17.10
Malocclusion	381	85.81	182	89.20	199	82.90
Receiving treatment	28	6.30	10	4.90	18	7.50
Treatment suggested	53	12.00	21	10.30	32	13.40
Family dentist	251	69.70	118	67.80	133	71.50
Straight teeth	216	62.60	108	67.90	108	58.10
Would wear braces	115	35.70	42	29.80	73	40.30
Fluoride in drinking water	329	76.30	149	74.50	180	77.90
Lip posture closed	255	88.20	115	86.50	140	92.10
Missing permanent teeth	45	10.40	12	6.10	33	14.20
No loss of maxillary first permanent molars	419	98.20	191	97.90	228	98.40
Loss of one maxillary first permanent molars	4	.90	2	1.00	2	.80
Loss of two maxillary first permanent molars	4	.90	2	1.00	2	.80
No loss of mandibular first permanent molars	396	94.70	190	99.00	206	91.10
Loss of one mandibular first permanent molar	16	3.80	2	1.00	14	6.20
Loss of two mandibular first permanent molars	6	1.50	0	.00	6	2.70
No missing lateral incisors	427	97.30	196	97.50	231	97.10
Missing one lateral incisor	5	1.10	1	.50	4	1.70
Missing two lateral incisors	7	1.60	4	2.00	3	1.20
No anterior crossbite	402	94.40	183	94.80	219	94.00
Anterior crossbite of one tooth	17	4.00	6	3.10	11	4.80
Anterior crossbite of two teeth	5	1.20	4	2.10	1	.40
Anterior crossbite of three teeth	1	.20	0	.00	1	.40
Anterior crossbite of four or more teeth	1	.20	0	.00	1	.40

TABLE XXXX

NUMBER AND PER CENT DISTRIBUTION OF SAMPLE ACCORDING TO EACH OF THE DISCRETE VARIABLES BY OCCLUSION

	Total Sample (N=444)		Acceptable Occlusion (N=63)		Malocclusion (N=381)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Acceptable occlusion	63	14.19	63	100.00	0	.00
Malocclusion	381	85.81	0	.00	381	100.00
Receiving treatment	28	6.30	0	.00	28	7.40
Treatment suggested	53	12.00	0	.00	50	13.20
Family dentist	251	69.70	42	84.00	209	67.40
Straight teeth	216	62.60	51	92.70	165	56.90
Would wear braces	115	35.70	4	7.30	111	41.60
Fluoride in drinking water	329	76.30	50	86.20	279	74.80
Lip posture closed	255	88.20	53	98.10	202	87.40
Missing permanent teeth	45	10.40	1	1.60	44	11.80
No loss of maxillary first permanent molars	419	98.20	63	100.00	359	97.80
Loss of one maxillary first permanent molars	4	.90	0	.00	3	.82
Loss of two maxillary first permanent molars	4	.90	0	.00	5	1.36
No loss of mandibular first permanent molars	396	94.70	63	100.00	335	93.80
Loss of one mandibular first permanent molar	16	3.80	0	.00	16	4.50
Loss of two mandibular first permanent molars	6	1.50	0	.00	6	1.70
No missing lateral incisors	427	97.30	63	100.00	366	96.80
Missing one lateral incisor	5	1.10	0	.00	5	1.30
Missing two lateral incisors	7	1.60	0	.00	7	1.90
No anterior crossbite	402	94.40	63	100.00	343	93.50
Anterior crossbite of one tooth	17	4.00	0	.00	17	4.60
Anterior crossbite of two teeth	5	1.20	0	.00	5	1.50
Anterior crossbite of three teeth	1	.20	0	.00	1	.27
Anterior crossbite of four or more teeth	1	.20	0	.00	1	.27

TABLE XXXI

NUMBER AND PER CENT DISTRIBUTION OF SAMPLE ACCORDING TO EACH OF THE DISCRETE VARIABLES BY SOCIOECONOMIC LEVEL

	Total Sample (N=444)		Socioeconomic Level					
			High (N=55)		Medium (N=314)		Low (N=75)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Acceptable occlusion	63	14.19	44	14.00	7	12.70	12	16.00
Malocclusion	381	85.81	270	86.00	48	87.30	63	84.00
Receiving treatment	28	6.30	17	5.40	10	18.20	1	1.40
Treatment suggested	53	12.00	32	10.20	17	31.00	4	5.30
Family dentist	251	69.70	199	65.30	52	94.5	75	100.00
Straight teeth	216	62.60	153	64.30	23	48.90	40	66.70
Would wear braces	115	35.70	73	32.90	23	54.80	19	32.80
Fluoride in drinking water	329	76.30	240	77.90	37	75.50	52	70.30
Lip posture closed	255	88.20	179	90.40	28	87.50	47	87.0
Missing permanent teeth	45	10.40	29	9.40	7	14.60	10	12.20
No loss of maxillary first permanent molars	419	98.20	303	98.60	55	100.00	70	94.60
Loss of one maxillary first permanent molars	4	.90	2	.70	0	.00	2	2.70
Loss of two maxillary first permanent molars	4	.90	2	.70	0	.00	2	2.70
No loss of mandibular first permanent molars	396	94.70	284	94.70	55	100.00	69	91.60
Loss of one mandibular first permanent molar	16	3.80	10	3.30	0	.00	6	8.40
Loss of two mandibular first permanent molars	6	1.50	6	2.00	0	.00	0	.00
No missing lateral incisors	427	97.30	304	96.80	53	96.00	75	100.00
Missing one lateral incisor	5	1.10	5	1.60	0	.00	0	.00
Missing two lateral incisors	7	1.60	5	1.60	2	4.00	0	.00
No anterior crossbite	402	94.40	290	93.80	55	100.00	70	93.10
Anterior crossbite of one tooth	17	4.00	12	3.90	0	.00	5	6.90
Anterior crossbite of two teeth	5	1.20	5	1.60	0	.00	0	.00
Anterior crossbite of three teeth	1	.20	1	.30	0	.00	0	.00
Anterior crossbite of four or more teeth	1	.20	1	.30	0	.00	0	.00

TABLE XXXXII

SIGNIFICANT EFFECTS REVEALED BY THE CHI SQUARE TEST FOR DISCRETE VARIABLES

	Sex		Occlusion		Socioeconomic Level	
Occlusion	3.59		444.00	***	.31	
Angle classification	.78		438.00	***	2.35	
Treatment	1.29		200.00	***	16.59	***
Treatment suggested	1.00		3.62	*	22.10	***
Dentist	.58		5.61		18.90	***
Straight teeth	3.56		25.35	***	4.46	*
Would wear braces	3.84	*	23.37	***	7.63	***
Fluoride in drinking water	.69		3.62		1.95	
Lip posture	2.39		5.32		.65	
Missing permanent teeth	7.52	***	6.09	*	1.48	
Missing maxillary first permanent molars	.06		1.40		6.60	**
Missing mandibular first permanent molars	12.69	***	4.10		6.21	*
Missing lateral incisors	.08		2.06		2.65	
Anterior crossbite	.14		4.36		13.07	***

* Significant at the 5% level.
** Significant at the 1% level.
*** Significant at the .1% level.

TABLE XXXXIII

SIMPLE-CORRELATION MATRIX REPRESENTING INDIVIDUAL PRODUCT-MOMENT CORRELATION COEFFICIENTS BETWEEN ALL POSSIBLE PAIRS OF 23 VARIABLES*

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Overjet																							
2. Overbite	38																						
3. Small rotations	08	13																					
4. Large rotations	19	18	35																				
5. Labio-lingual spread	09	17	45	72																			
6. Anterior crossbite	26	14	06	03	19																		
7. Missing permanent teeth	07	02	01	07	05	03																	
8. Facial angle	07	01	05	11	12	01	10																
9. AB to facial plane	31	33	03	01	-01	-07	-15	07															
10. ANB	34	17	02	07	-02	-21	-17	-08	72														
11. ANP	29	04	-05	07	01	-16	-12	-18	46	84													
12. Lower lip-chin-facial plane	19	-09	01	03	01	-05	04	-17	08	40	54												
13. Lower lip-upper lip-facial plane	15	23	01	04	01	-05	-24	02	61	58	38	-01											
14. Nose angle	21	-03	-01	05	11	13	09	-01	-50	-60	-56	-31	-27										
15. Orientation angle	12	-05	-01	-09	-08	-01	13	67	-10	-13	-16	-22	-03	06									
16. Maxillary facial angle	32	05	-02	02	-04	-02	-08	-15	29	71	77	72	35	-42	-12								
17. Upper lip-nose-facial plane	-11	06	-03	09	-05	-05	-03	-19	12	-21	-28	-31	-16	-14	-04	-50							
18. Nasal angle	-20	01	-02	01	08	04	14	-09	03	-16	-11	03	-12	14	01	-23	33						
19. Maxillary angle	-03	-10	15	09	10	-05	-03	-14	-04	10	14	01	02	-19	11	02	-27	06					
20. Mandibular angle	06	-08	12	09	11	-15	04	-38	-26	17	29	22	-07	03	-05	37	-20	12	13				
21. Handicapping labio-lingual deviation index	54	64	30	43	50	08	-12	-11	25	18	10	07	17	-01	-07	13	-05	-04	-06	03			
22. Treatment priority index	40	37	35	58	45	03	-13	-10	13	14	09	07	07	-02	-11	06	-06	-08	04	08	57		
23. Total photo score	32	14	14	22	21	01	-14	-19	13	29	33	32	18	-11	-26	33	-09	-12	-05	17	38	33	

* Decimal points omitted.

GLOSSARY

Photographic Landmarks

Nasion (N) The most concave soft tissue point at the root of the nose corresponding to the junction of the frontal and nasal bones.

Orbitale (O) The soft tissue point corresponding to the deepest point of the infra orbital margin of the bony orbit. It is directly below the pupil when the eye is open and looking directly ahead.

Pronasale (PRN) The most anterior point of the nose in the midsagittal plane.

Subnasale (SN) The point at which the nasal septum between the nostrils merges with the upper cutaneous lip in the midsagittal plane.

A Point (A) The soft tissue point corresponding to the deepest point on the midline contour of the alveolar process between the anterior nasal spine and the alveolar crest of the maxillary central incisor.

Labrale Superius (LS) The point at the superior margin of the upper membranous lip in the midsagittal plane.

Labrale Inferius (Li) The point at the superior margin of the lower membranous lip in the midsagittal plane.

B Point (B) The soft tissue point corresponding to the deepest midline point on the mandible between infradentale and pogonion.

Pogonion (Pg) The most anterior point on the soft tissue chin in the midsagittal plane.

Menton (Mm) The most inferior point on the soft tissue chin in the midsagittal plane.

Tragus (T) The tip of the soft tissue, tongue-like projection of the cartilage of the auricle in front of the opening of the external auditory meatus.

P-Point (P) The geometric midpoint of facial plane (N-Pg).

Reference Planes used in this study

Facial Plane Constructed from nasion to pogonion (N-Pg).

Orientation Plane Constructed from tragus to P-point.

Frankfort Horizontal Plane Constructed from tragus to orbitale.